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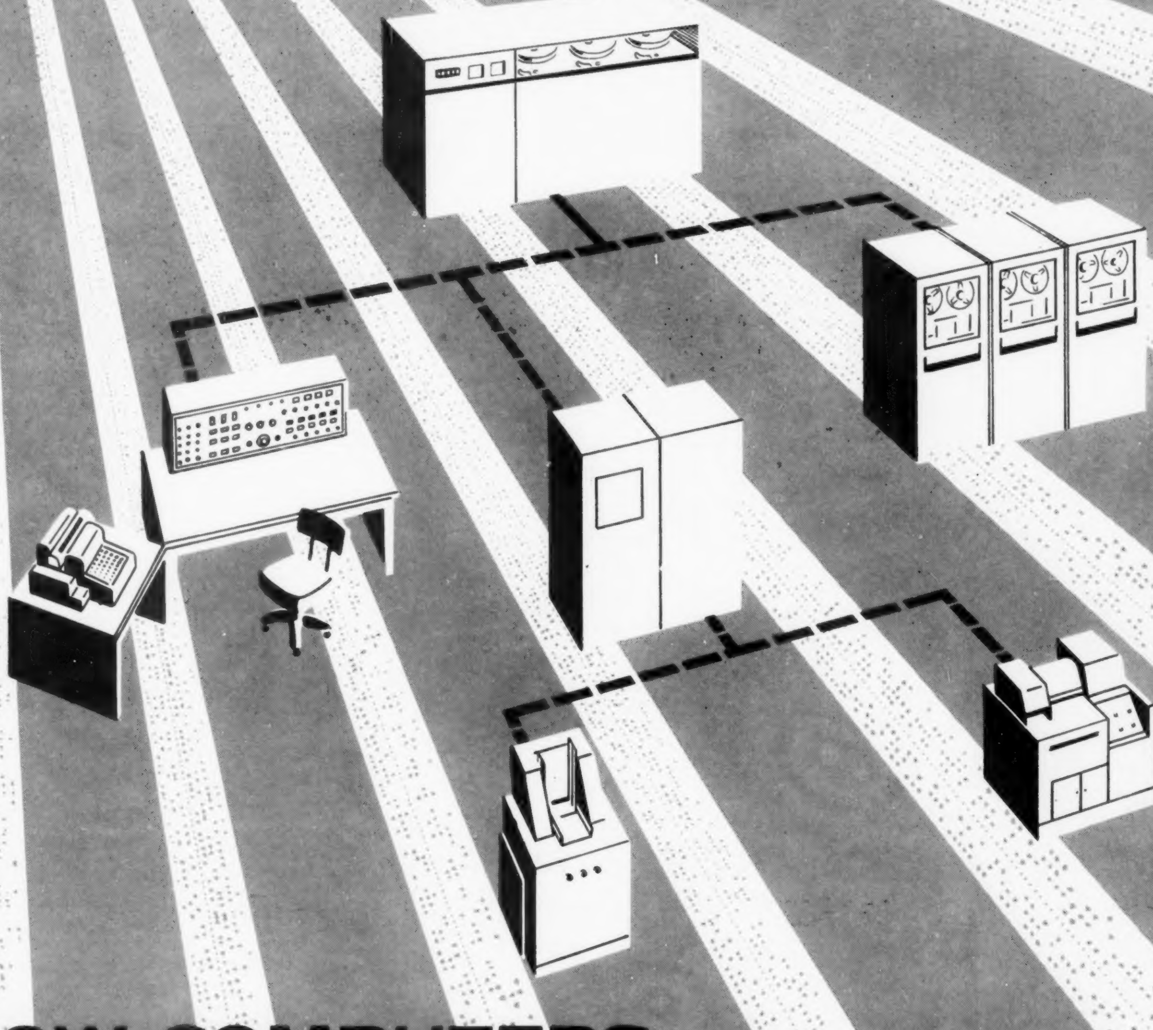

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VOL. 23, No. 7 — June 1961

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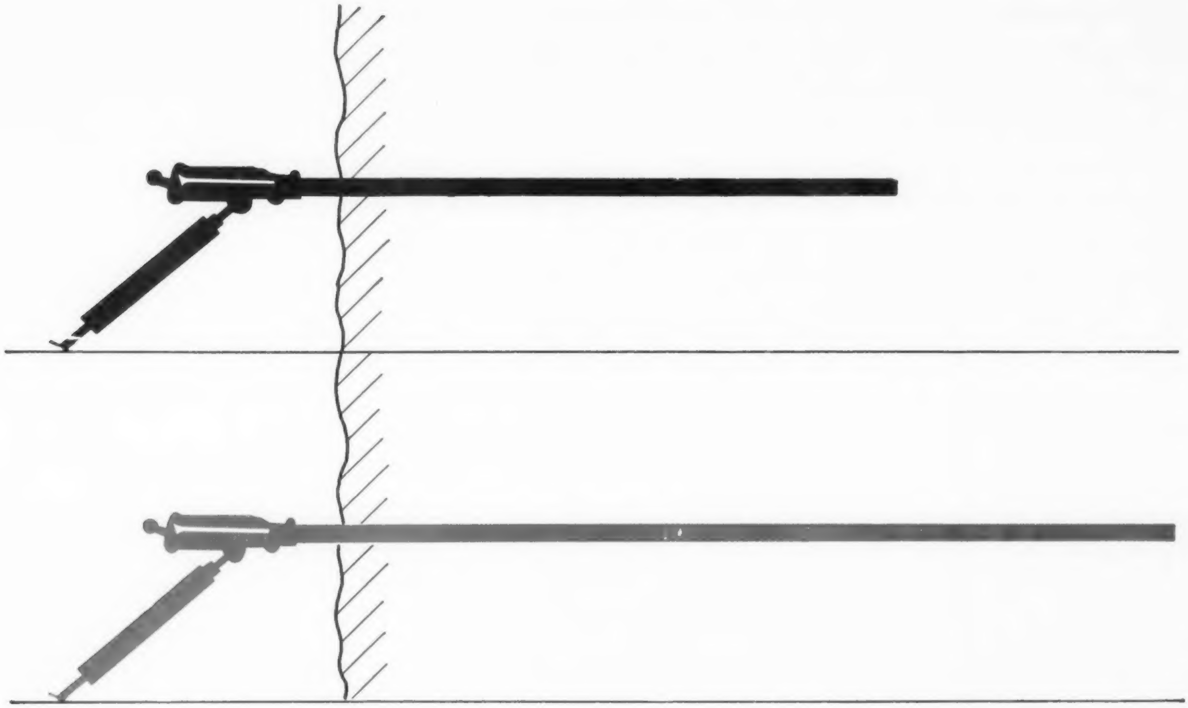

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Never before in the history of rock drilling has there been a feed-leg drill that could do so much, so easily, as Ingersoll-Rand's new JR-300 Universal Jackdrill. On performance alone, it is 40 to 60% faster than preceding models.

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You Can Use Computers

There are few, very few, mining companies that can afford to set up their own computer centers because of the high costs. Not even one mining company, large or small, can afford not to use computers for many phases of operations.

This special Computer Issue of MINING WORLD outlines a wide variety of computer applications including the following: calculation of ore reserves, solving surveying traverses, determining haulage schedules, optimum equipment utilization, determining ratios of ore to waste, selecting exploration targets, ore blending, exact mining costs, limits of open pit expansion, setting pit slopes, stope costs and extraction rates, production scheduling, ore recovery predictions, engineering design problems, optimum overall mining plans, mill process control, analysis of geological data, geophysical data processing, payroll and bonus bookkeeping, production standards, mining research, determination of cut off grade, inventory replacement, equipment balancing, minimum cost determination, digital terrain analysis, and many many more.

Fortunately, every company can use computers by taking advantage of the computer consultants, using existing programs in computer libraries to which are added your data for similar problems, and renting computer time at one of many computer centers.

You can't afford not to use computers.

S. Dayton Wins Neal Award

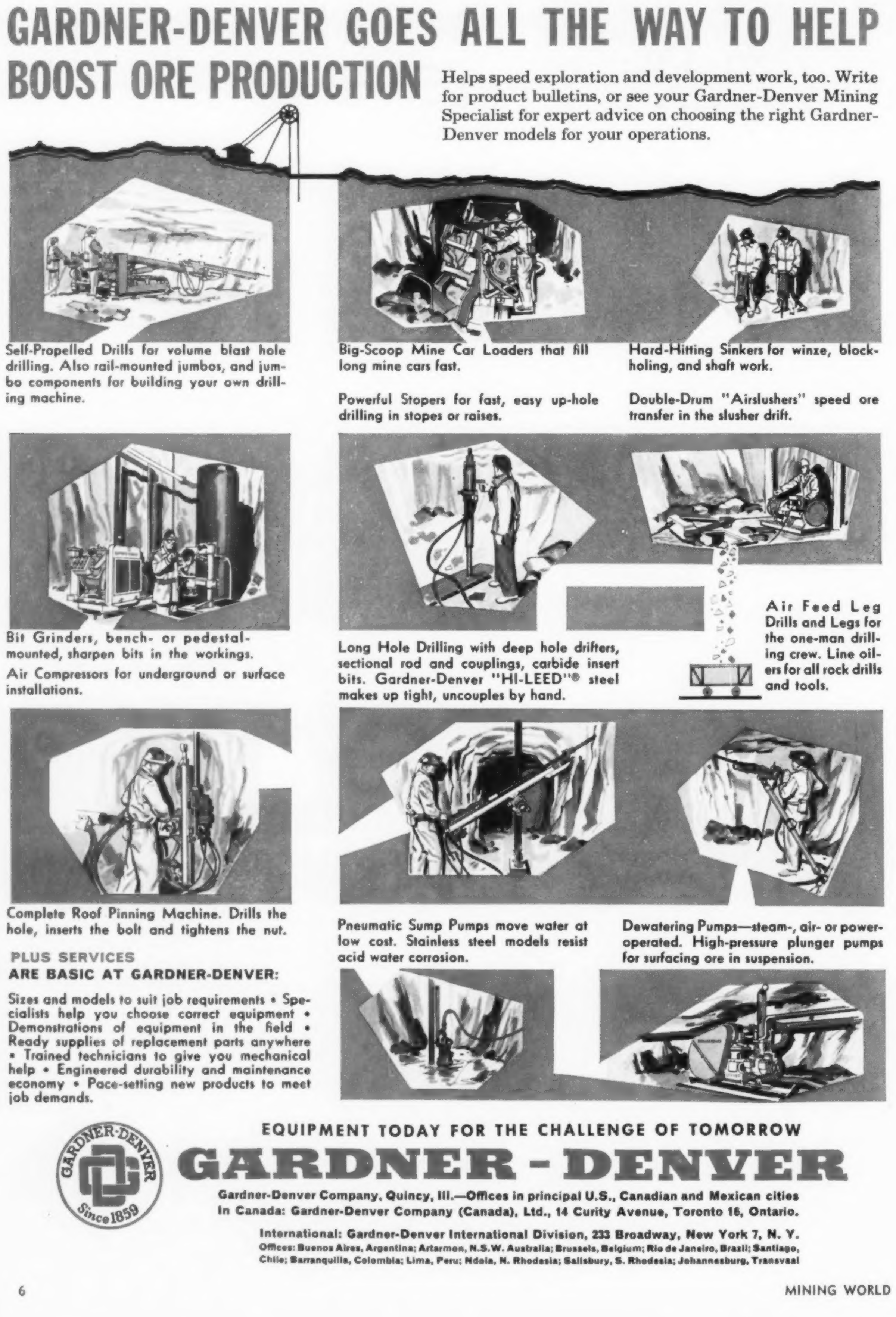
Stanley H. Dayton, (left) associate editor of MINING WORLD accepts the Award of Merit from H. C. McDaniel, director, Technical Information, Westinghouse Electrical Corporation in the Seventh Jesse H. Neal Editorial Achievement Award contest.

The award was presented in Class III competition for business magazines with a circulation between 8,000 and 13,000 by Associated Business Publications in tribute to Editorial Leadership.

Mr. Dayton won the award for the work he did in creating, writing, and designing the special May 1960 issue of MINING WORLD titled "South American Mining Boom." This was his issue in every respect. Stan obtained the data by interview and travel and through strategic correspondents, wrote the articles, even planned the art design and page layouts.

The citation to accompany the award reads: "For South American Boom, a special issue which summarized, for the first time, the mineral resources of South America by mineral commodity instead of geographic boundary, and devoted to the basic premise that this hemisphere can be mineral self-sufficient."

The award is just tribute for Editorial Leadership in the minerals industries and Stan's superb job in technical editorship.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GOVERNMENT ACTION AND REACTION AFFECTING MINING

Aspinall-Anderson Lead-Zinc Bill Faces Tough Going in Congress . . .

On January 26, 1961, Representative Wayne Aspinall, chairman of the House Interior Committee, introduced H. R. 3416, a bill to stabilize the mining of lead and zinc in the United States. Being a tariff measure, it was referred to the Ways and Means Committee. The bill is also a subsidy measure, based upon the so-called "San Francisco plan" whereby money obtained through the tariffs on imported lead and zinc are to be used to make up the difference between the market price of each metal and 16 cents per pound under certain conditions set forth in the bill, and limited to the first 2,000 tons of production per year.

On April 27, 1961, Chairman Anderson of the Senate Interior Committee, together with Senators Carroll, Bennett and Moss, introduced S. 1747—a companion bill to H. R. 3416. In the Senate all tariff measures come within the jurisdiction of the Finance Committee, but by some legerdemain this bill was referred to the Senate Interior Committee. This action, if the Finance Committee does not promptly demand jurisdiction, will permit the Interior Committee to hold hearings on S. 1747 and once more air the troubles of the domestic lead-zinc industry.

The bill, in addition to the subsidy feature, would levy a permanent tariff of 2 cents per pound on lead and zinc metal and 70 percent of this amount or 1.4 cents per pound on ores and concentrates. Also, a removable tariff of the same amount on both metals is to be applied should the price fall below 13.5 cents per pound, and is to be removed when the market goes above 14.5 cents per pound. Compensatory tariffs also would be applied to imported lead-zinc manufactured goods.

Considering the present temper of Congress and the Administration, informed government sources do not give the Aspinall-Anderson bill a chance to become law, at least at this session of the Congress.

Minerals Policy Still To Be Formulated By Interior . . .

Speaking in San Antonio, Texas, on April 11, assistant secretary of the Interior John M. Kelly remarked ". . . in the group of metals which in their own right are as essential to our economic well being as oil, serious difficulties have been encountered in recent years. I speak primarily of lead, zinc, and copper.

"Lead and zinc have been subject to declining domestic production and increasing pressure from imports. The copper industry has been affected materially by events in different parts of the world with resulting instability, although production has expanded. . . . These are pressing problems which require—and which will get—a substantial portion of my energies and the energies of my staff."

At press time there had been no announcement of Administration policies in the field of copper, lead, and zinc and no recommendations have been made to the Congress.

Interior Committee's Lack Of Mining Engineers Noted . . .

A fair measure of the state of lassitude the Congress and the government agencies have fallen into regarding mining legislation is the strange fact that for the first time in years neither the Senate nor the House Interior Committee has a mining legislative expert to service its mining subcommittee, either on permanent staff or as consultant. This may be because the volume of potentially passable legislation (not bills) is so low that the service would not be profitable. Yet good staff members can do a great deal to schedule hearings and to move legislation on its way.

A peculiar apathy seems to exist both on the part of the various segments of the industry and the responsible government agencies, which has communicated itself to the committees. These groups, as a rule, are not self-starting. There is always plenty to do without taking on additional chores in which there is lack of interest or the probability of a veto.

So many good bills have failed to become law in the past several years, even when enormous effort has been spent on them, that the present lassitude may be understandable, but it certainly is undesirable.

Sale of Reserved Mineral Rights Proposed . . .

Representative John Kyl of Iowa has introduced a bill (H. R. 6585) which would permit the owners of surface rights, where the government has reserved the mineral rights, to purchase such rights "unless the land is the subject of a mineral lease, license or permit from, or under exploration or development by, the United States or a person acting under its authority or with its permission." Presumedly this reservation would also apply to valid mineral locations. Aside from certain fees which must be paid when the application for the subsurface rights is made, the bill also calls for paying, "as an additional sum, the fair market value of the reserved minerals in place as determined by the Secretary" (of the Interior).

Several bills to dispose of reserved mineral rights contain this latter clause. However, no mention is ever made concerning the kind of a crystal ball the Secretary can use to make this determination!

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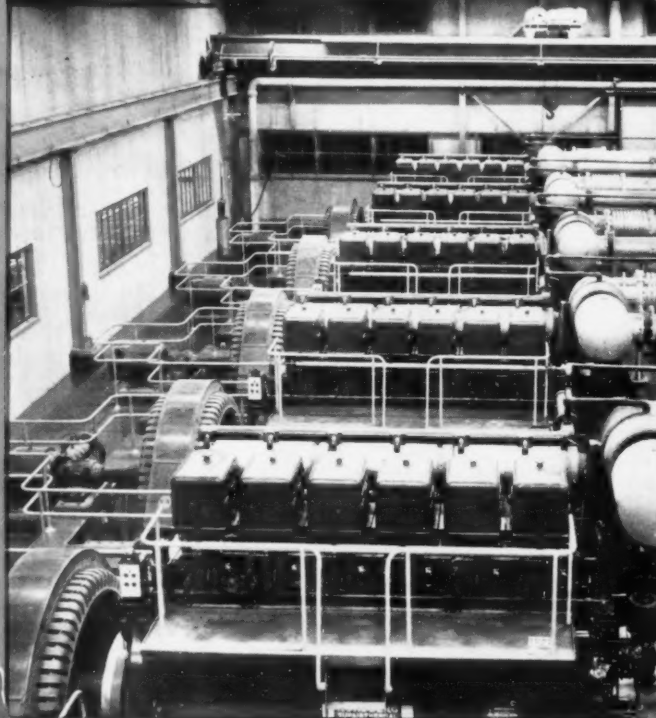

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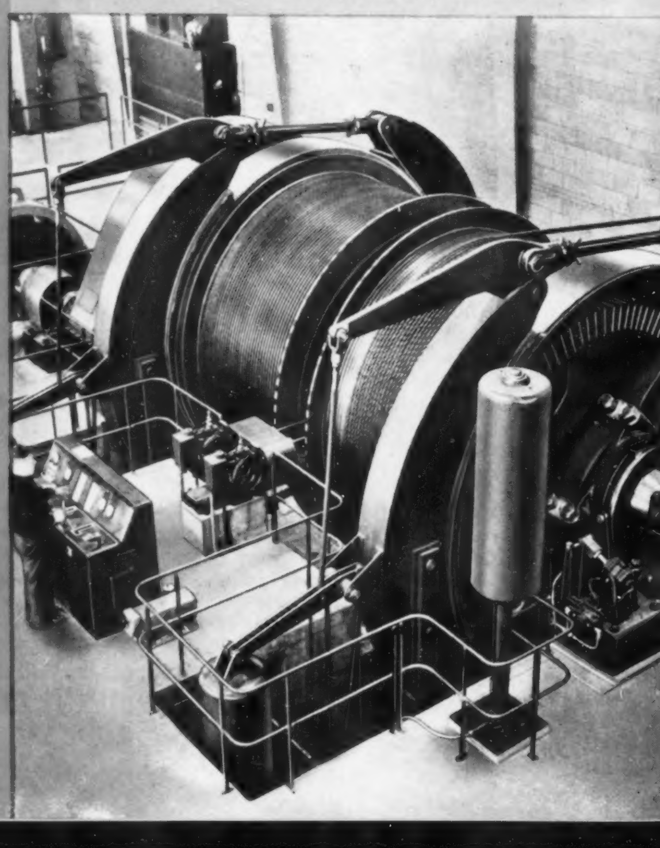

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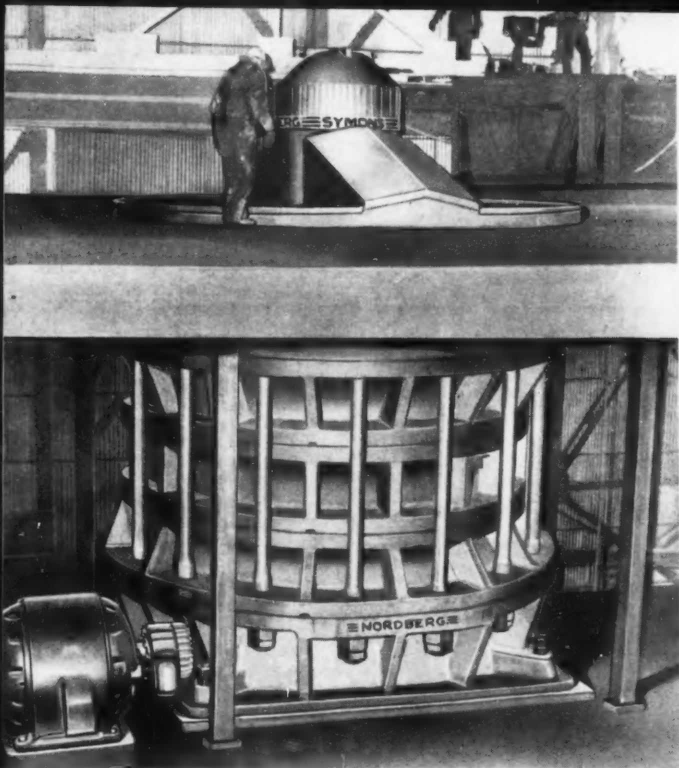

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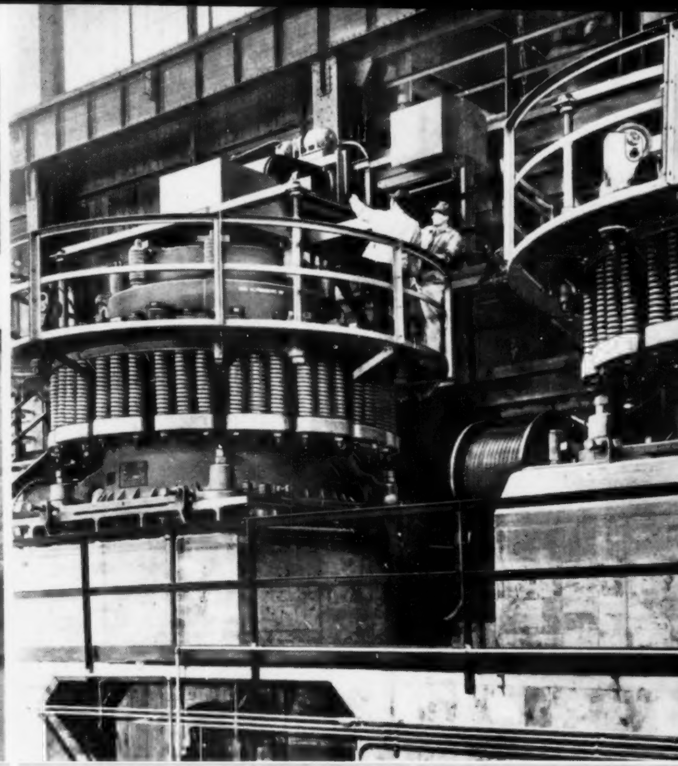

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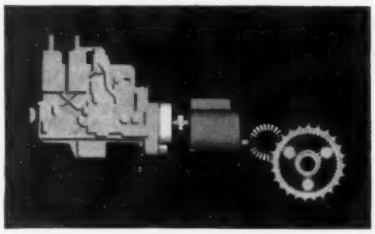
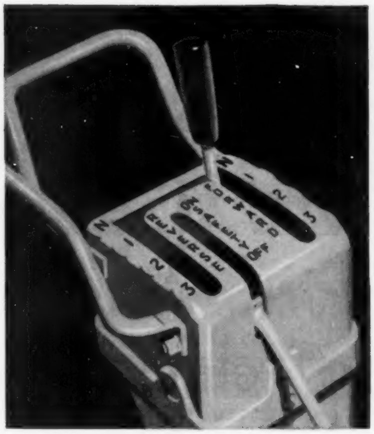
CAT D353 ENGINE AND MATCHED POWER TRAIN This engine, rated 385 HP (flywheel) at 1330 RPM, has been proven—and proven again—over thousands of hours on the roughest jobs. Its 6.25" x 8" six-cylinder design now incorporates *controlled turbocharging* and aftercooling (found only in the D9G among crawler tractors), assures more efficient use of fuel, increases maximum torque and provides fast engine response over a wide range of operation. Shroud-mounted fan reduces air recirculation; torque limiting clutch saves on fan horsepower. Plus: exclusive Caterpillar fuel injection system, twin dry-type air cleaners, oil-jet-cooled pistons, "Hi-Electro" hardened cylinder liners and crankshaft journals.



The new power train includes three major advances: *new oil-cooled steering clutches and brakes, new planetary final drives*, and a time and cost saving *common lube system*. The new spring-engaged, hydraulically-released steering clutches need no adjustments... have a proven longer service life. New, planetary final drives increase gear reduction ratios from 8.8:1 to 18:1, reducing torque load on all power train components. A common system cools and lubricates torque divider, transmission, bevel gear, steering clutches and brakes. This means one service point... one type of oil. The entire power train of the big new D9G has unitized construction for fast, individual removal of components.



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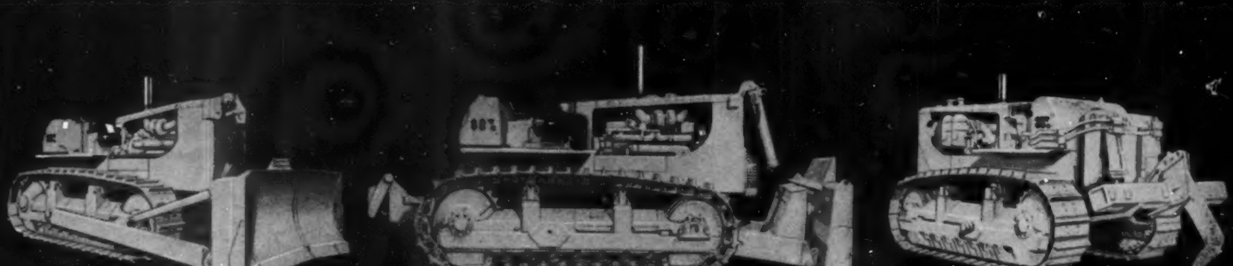

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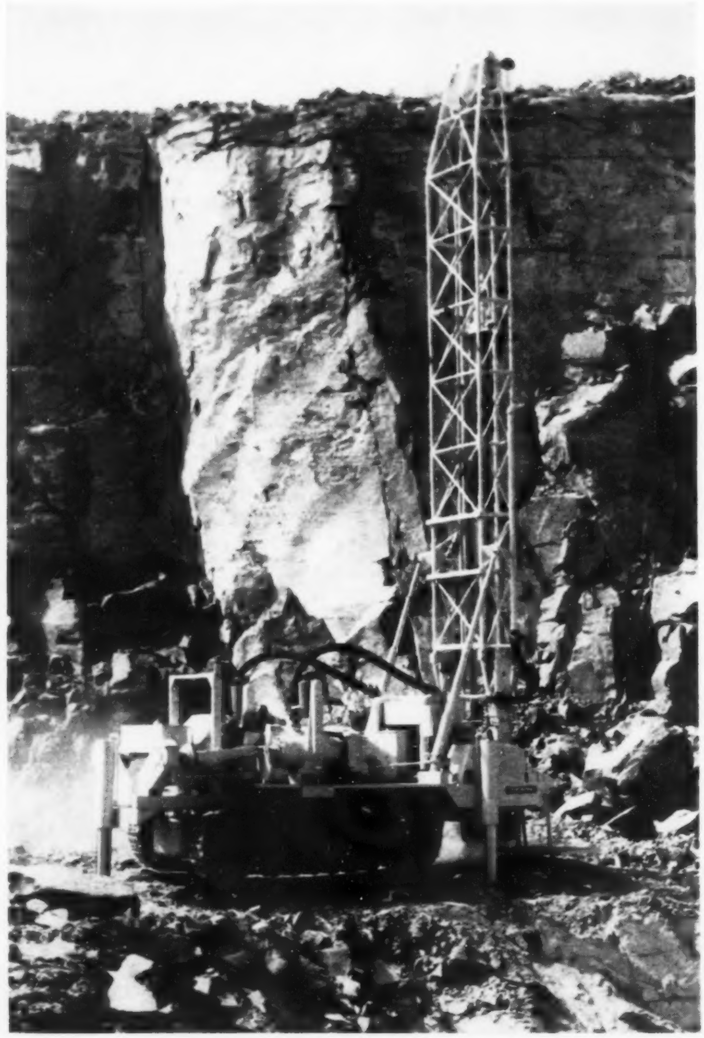

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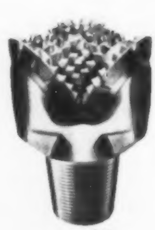
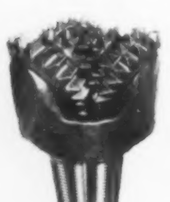
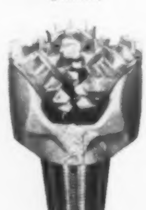


Type **H**
ROTA-BLAST
Formerly type W7R for hard rock (Siliceous limestone, dolomite, sandstone, granite)



Type **M**
ROTA-BLAST
Formerly type OW for medium rock (Limestone, sandstone, sandy shales)



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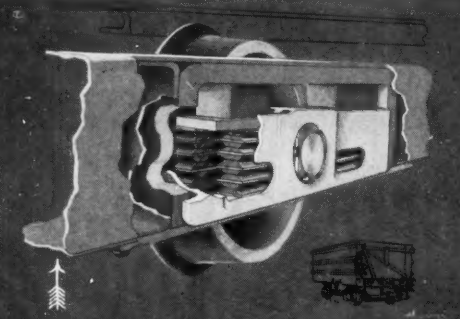
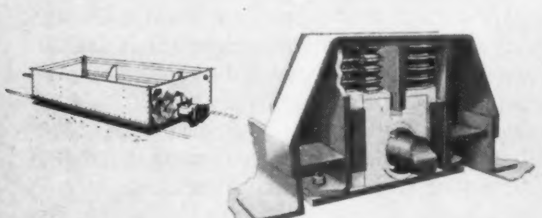
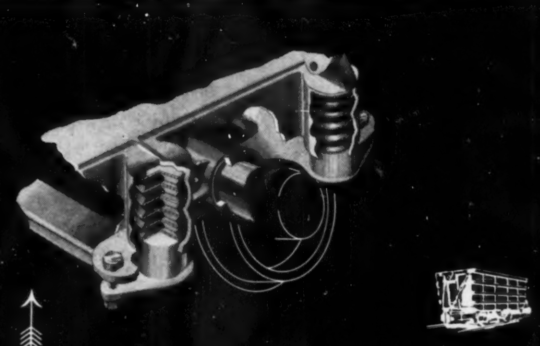


② Twin National MI-235 units used on each side of the axle center line and outboard of the wheels.



③ Twin National MI-240 units used on each side and over the axle inboard of the wheels.



④ Twin National MI-240 units, used in narrow body cars, are located in line with wheels to eliminate side overhang.

Providing more bail pull, maximum dipper fill factor, low per-ton loading cost—Magnetorque Hoist Drive on 17-year-old P&H 1400 refuses to show its age.

After 17 years, first Magnetorque equipped

. . . at MISSOURI PORTLAND CEMENT CO.

Virgil Wendt, Quarry Supt., reports—

"Back in 1944, we bought the first P&H ever sold with Magnetorque; today this 1400 still gives us good, reliable service. If our plant needs extra limestone, we think nothing of working this shovel for 16 hours at a stretch. We still rely on it to do the job for us. Teamed with the P&H 1500 we bought in 1958, it gives us as efficient a digging operation as you'll find anywhere."

Two P&H Electrics Load 1,123,000 Tons Annually

To meet quarry production schedules, Missouri Portland's modern, five-million barrel cement plant demands absolutely dependable equipment. Two types of rock must be dug daily to supply the right "mix." To accomplish this, the two P&H Electric Shovels work at different levels along an 1835 foot long quarry face.

Equipped with a 4-yard dipper, the P&H 1400 has seen years of hard, workhorse service. One year it loaded over 750,000 tons. Now it digs at the base of the quarry's upper face, loading up to 360 tons of limestone an hour. The newer, 5-yard P&H 1500 digs at the base of the lower face, loading up to 400 tons of limestone an hour without hesitation.

Magnetorque Helps Maintain High Production

Exclusive Magnetorque Hoist Drive on these P&H machines is the key to their greater productivity. It gives more digging bail pull—puts more material in the dipper faster, with every pass. Mr. Henry Merz,

20-ton capacity trucks are loaded at the rate of about 15 loads per hour. P&H 1400 with 4-yard dipper shows it's still a workhorse.

Quick, accurate dipper spotting results from responsive electronic controls on 5-yard P&H 1500. Loads 18 to 20, 20-ton trucks per hour.

P&H electric is still going strong

Fort Bellefontaine Quarry in St. Louis County

Quarry Foreman, says—"The electronic controls on our P&H shovels are very responsive and the Magnetorque hoist drive is especially powerful."

Superior P&H Parts And Service Is Worth A Lot

Mr. Virgil Wendt has this comment to make—"I think one big reason the 1400 is still going strong is that P&H really stands behind its equipment with immediate help, should it be necessary. This is worth a lot. Harnischfeger not only builds a good shovel, but helps keep it working right."

Summary Report On 17 Year Old P&H 1400

Here is how Mr. H. Clay Iten, Plant Manager, puts it—"We have no plans to replace our P&H 1400 after all these years. It's always done a good job for us; it's doing a good job for us now, and we expect it will continue to do so."

Compare all performance factors before you buy—for more detailed information on this operation, write for Case History Report No. 141 to the World's Largest Builder of Full-Electric Shovels.

HARNISCHFEGER P&H

Milwaukee 46, Wisconsin

CONSTRUCTION & MINING DIVISION

Tee'd off about grinding balls?

Then call that old pro, your CF&I salesman. *He* can supply grinding balls that will give you a better score and keep your mill throughput up and your blood pressure down.

Made from forged alloy or carbon steel, every CF&I Grinding Ball is up to par—outstanding resistance to wear and impact splitting . . . exceptional uniformity of roundness, density and other physical properties. CF&I Grinding Balls are available in the following diameter sizes: Forged Alloy Steel — 1½" to 4"; Forged Carbon Steel — ¾" to 5". No matter which you choose, you're going to be down the middle of every fairway and putting for a birdie.

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Other quality CF&I Steel Products for basic industries
Grinding Rods • Mine Rails and Accessories • Rock Bolts • Realock Metallic Fabric • Industrial Screens • Wickwire Rope • Grader Blades

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Eliminate any possibility of grade confusion. Use Trojan color coded explosives. Each grade of Trojan explosives is now marked with its own distinctive color to ensure having the right grade in the right place at the right time. Loading is faster—more accurate.

This is but one of many new advantages Trojan offers in a complete line of explosives for every blasting need, plus technical assistance with your blasting problems. For further information call our local representative or write: Trojan Powder Company, 17 North Seventh St., Allentown, Pa. *Est. 1905.* Sales Offices: Allentown, Pa. • San Francisco & Los Angeles, Calif. • Portland, Ore. • Kansas City, Mo. • Wolf Lake, Ill. *Distributing magazines in principal consumer districts.* Explosive plants: Allentown, Pa. • Wolf Lake, Ill. • San Leandro, Calif.

New bulletin #101 upon request

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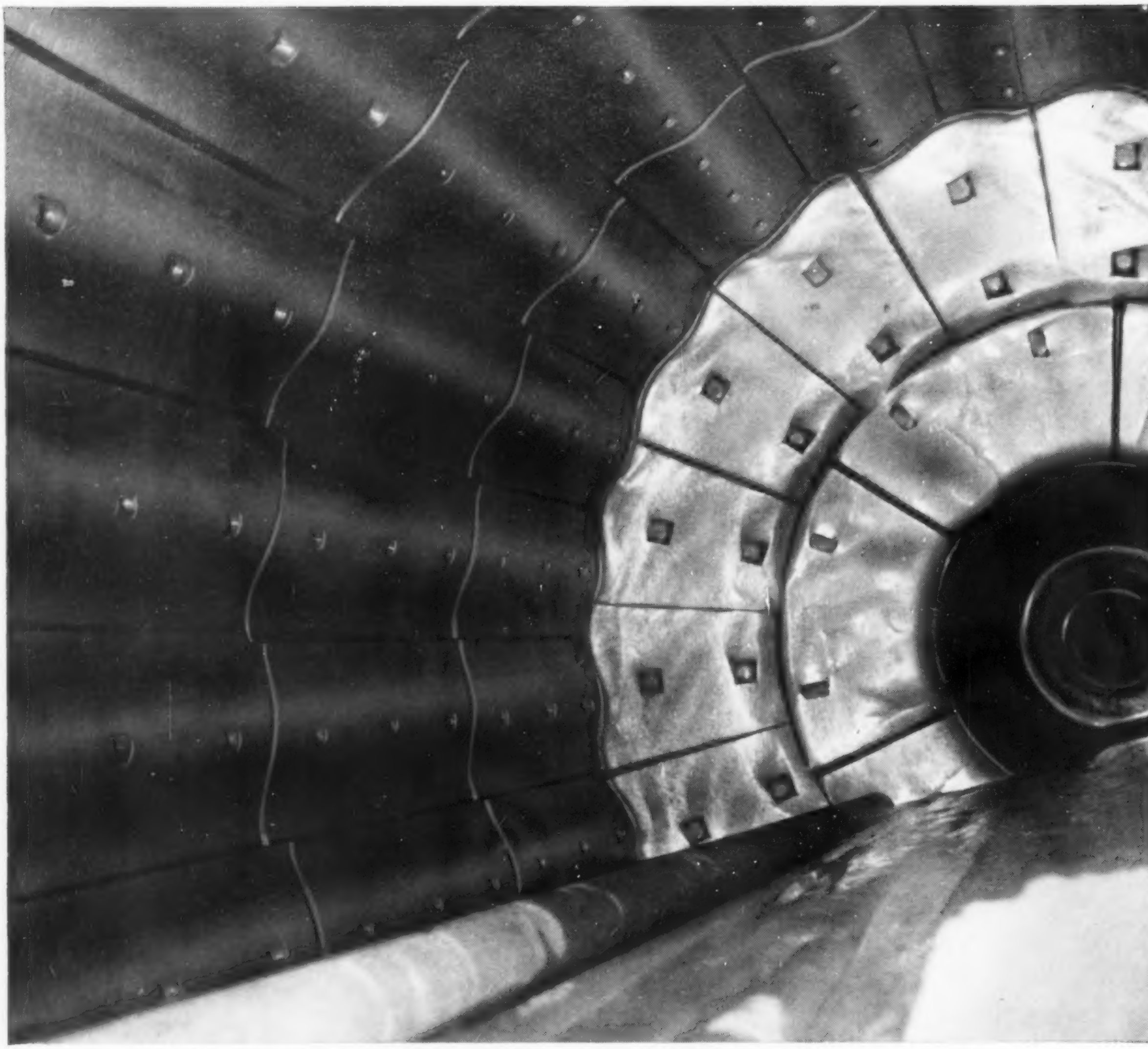
HIGH EXPLOSIVES • BLASTING AGENTS • SEISMIC EXPLOSIVES • PERMISSIBLES
CUSTOM-DEVELOPED EXPLOSIVES TO MEET SPECIAL REQUIREMENTS • BLASTING SUPPLIES



The Ni-Hard iron liners in this rod mill have saved over $16,000. Cost per ton of ore dropped to 0.89 cents, compared with 2.50 cents per ton for manganese steel liners formerly used.

In this rod mill 2 years . . .

Ni-Hard liners save over $16,000

Two years ago, Canadian Malartic Gold Mines installed Ni-Hard* nickel-chromium white cast iron liners in their rod mills. A profitable move: in grinding 933,000 tons of abrasive gold ore, Ni-Hard iron liners have saved over $16,000.

2 years' service, only 20 hours downtime. This cost-cutting performance is due to the outstanding abrasion resistance of Ni-Hard iron. Not only is its structure as hard as fully hardened steel, but it contains firmly embedded hard carbides which help it withstand particularly abrasive punishment.

You can slash costly downtime and increase the efficiency of your mill operation by specifying Ni-Hard liners. They can double or triple the intervals between mill relinings, often holding their original contour right down to the last quarter-inch. Labor and maintenance costs are also minimized with Ni-Hard liners.

Contact your Ni-Hard producer and arrange to try a set of Ni-hard liners in your mills. He can also give you valuable information on this wear-resistant nickel-alloyed cast iron for other parts used in ore processing equipment — such as feed spouts, pipe elbows and fixtures, slurry pump liners, impellers and wear plates.

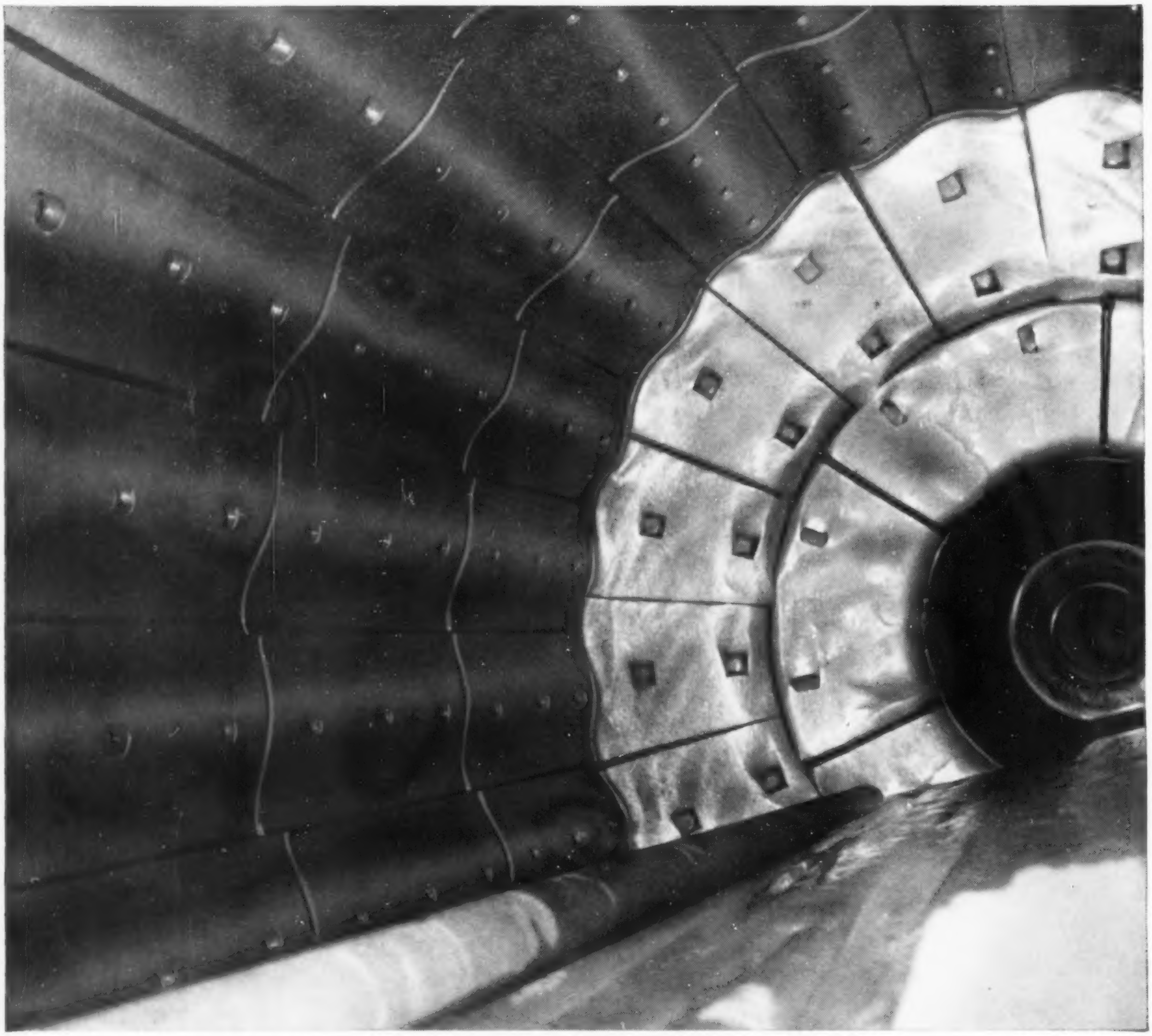
*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

NI-HARD

NICKEL MAKES CASTINGS PERFORM BETTER LONGER

MORE JOB VERSATILITY ▵ **LOWER OPERATING COSTS** ▵ WITH THE **'EUC' C-6**



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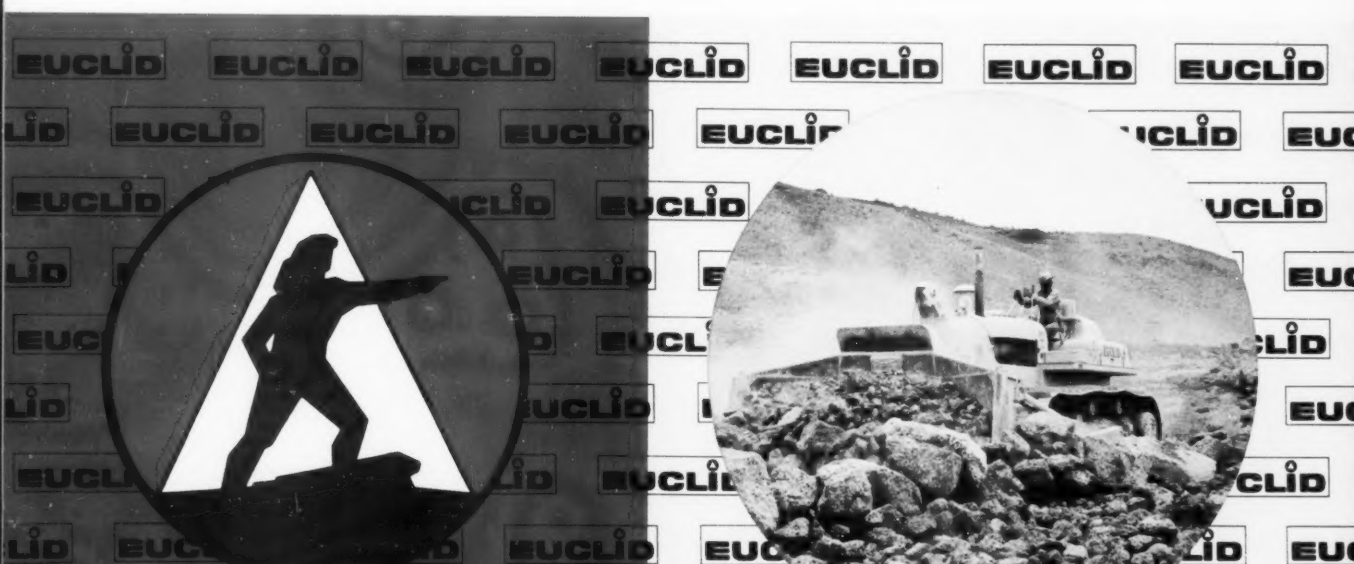


EUCLID C-6 LOWEST COST

Saves time and labor . . .

Job proved components and unsurpassed accessibility for day-to-day maintenance, as well as major repair work, keep downtime and operating costs to an absolute minimum. There's a big difference between the C-6 and its closest competitor . . . for example:

Service accessibility . . .

Fast, easy access to major components cuts repair and replacement labor.

- ***save 7 hours** on radiator replacement*
- *change a drive sprocket **5 hours faster***
- ***17 hours saved** on recoil system replacement*
- *engine replacement in **6 hours less***

These are typical times for removal and replacement without the prior removal of any integral components . . . think what these savings in time and labor can mean in lower operating costs and increased productive work time!

Power train . . .

Proven components . . . GM 6-71 engine, Allison Torqmatic Drive and Euclid planetary final drive . . . dependable, efficient and balanced, it delivers more of the rated engine horsepower to the drive sprocket than any comparable power train . . . and parts and service are readily available to owners everywhere!

Lower cost engine parts . . .

Individual engine parts, such as pistons, rings, liners and connecting rods, are up to 72% less in cost than for more limited production engines . . . a fan-to-flywheel engine replacement costs only one-half to two-thirds as much in the C-6!

See a "EUC" C-6 at work and see the big difference that pays off in lower cost!

TRACTOR IN THE 200 H.P. CLASS
...and the most versatile, by far

DOES MORE WORK...and a better job on more kinds of work

Because the C-6 is the most versatile crawler in its class, it's a more productive tractor. Matched power train...full-power shift...fast-as-a-fox response . . . better balance with any attachment . . . and easy operation . . . these are features that enable the C-6 to handle more work better and more efficiently.

When it comes to over-all productivity . . . on all kinds of tractor work . . . the "Euc" C-6 has earned a reputation for remarkable performance. Owners and operators alike report that it has more versatility and is more useful for a wide range of work from side sloping to the heaviest dozing and ripping.

You really have to see a C-6 at work to see what this versatile crawler can do in getting more work done . . . cutting costs and protecting your profits!

'EUC' C-6 VERSATILITY

CUTS CRAWLER COSTS

No other crawler in its class can do so many jobs so well at such low operating cost . . . no wonder this Euclid is the talk of crawler users everywhere!

Form No. 609-P Printed in U.S.A.

EUCLID

DIVISION OF GENERAL MOTORS, HUDSON, OHIO

Plants at Cleveland and Hudson, Ohio and Lanarkshire, Scotland

Arizona's Planet Mine To Reopen To Ship Iron Ore to Japan—Steel Mill Proposed by New Company

Golden Gate Mining Company, Inc. has acquired several western Arizona iron ore deposits, including the New Planet on the south bank of the Bill Williams River, 28 miles from Bouse, according to Elmer C. Von Glahn, president, and Howard Birchfield, vice president.

A beneficiation plant is scheduled for construction to upgrade ore for shipment to Japan from Parker, via railroad, to ships at the Los Angeles harbor. Exports will end when the proposed steel mill to produce reinforcing bars is completed at Parker. Mining, operation of the beneficiating plant, and hauling are to be directed by Fred Rood, of Little Rock, Arkansas.

The New Planet is an old copper mine owned by New Planet Company, New York, New York, which has produced about 50,000 tons of 10 percent copper. Iron has been known for many years, but never mined.

The hydrothermal iron is specular hematite that has partly to completely replaced limestone and to a much lesser extent schist. Minor minerals include chalcopyrite, pyrite, quartz, and copper oxides. The schist with irregular tabular masses of limestone is thrust over an older basement gneiss.

In 1943 and 1944, 12 churn and 10 diamond holes were drilled by the U. S. Bureau of Mines to indicate 1,120,000 tons of ore in an area 250 feet wide by 1,000 feet long. Ore cropped out in this area and a minimum of 650,000 tons could be mined by open pitting. Indicated grade was 56.42 percent iron, and 13.5 silica. There are also other outcrops that indicate 225,000 tons of 50 percent iron could be mined from several smaller pits. In general there are two beds of ore separated by schist. Ore thicknesses are from 12 to 35 feet as indicated by drilling and underground work.

In addition to the high-grade ore, the drilling disclosed an area of 4,400,000 square feet in the southern part of the mineralized area with an average depth of 175 feet and a thickness of 50.25 feet containing an indicated 21,000,000 tons of 35.00 percent iron and 40 percent plus silica. This is based on only eight widely spaced holes, however.

This low grade material could, of course, be mined by open pitting and by doing so higher grade lenses known to be present could be selectively mined. The bulk, of course, would have to be beneficiated before use.

Climax Will Diamond Drill Colorado's Urad Molybdenite Deposit

Under the impetus of a very high demand, an increased price, and a strong forward market there is a great search for molybdenum deposits as well as reevaluation of known sources. These are the reasons that, the Urad molybdenite deposit on Red Mountain west of Empire, Clear Creek County will be reevaluated as a source of molybdenum by Climax Molybdemum Company which has secured a lease and option on the property from Vanadium Corporation of America.

During World War II the lease was held by Molybdenum Corporation of America which secured a DPC loan, reopened the mine, drove a 1,100 foot raise to upper workings, mined ore, built and operated a 250-ton-per-day flotation mill, and produced concentrate. Shortly after the war ended, the mine was closed. During World War I about 100,000 tons of ore was mined by Primos Chemical Company.

Molybdenite is associated with an east-west vein system dipping 45 to 50° north cutting pre-Cambrian granite and schist adjacent to a quartz monzonite porphyry stock. The vein system intersects the vertically dipping stock at depth. Early mining was for high grade ore in the narrow veins. Recent exploration has confirmed mineralization to as much as 50 to 100 feet on each side of the vein. This larger tonnage of low grade material is Climax's target for a low cost block caving operation. A new much larger mill would have to be built before any major production can be made.

Tri-State and American Zinc Will Develop New Tennessee Mine

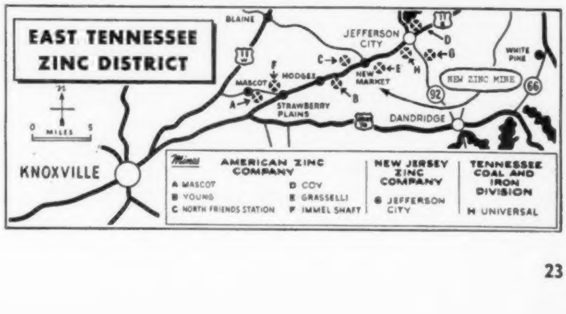
Under a joint venture known as New Market Zinc Company, the Tri-State Zinc. Inc. (a wholly owned subsidiary of the Consolidated Gold Fields of South Africa, Limited) and the American Zinc Company of Tennessee will develop a new underground mine at location shown on adjoining map.

Tri-State will be the operator. Reserves are at least 20,000,000 tons of about 3.5 percent zinc ore. This ore will be treated in a new 3,600-ton-per-day mill which is scheduled to have an initial capacity of 2,800 tons per day in mid-1962. American Zinc has the option to use the mill for treating its own ores until Tri-State completes development of the new mine which may require two or three years.

The initial agreement was signed in May 1960 and since then Tri-State has check-diamond-drilled the area and confirmed American Zinc's tonnage and grade figures determined by earlier drilling.

The East Tennessee zinc district shown on the map is now the largest zinc producing area in the United States. Sphalerite is found in flat-lying Kingsport dolomite filling fractures and brecciated zones. Open stopes with random pillars are mined with off-track Dieselized equipment in the district.

Tri-State operates zinc mines in Illinois and Virginia. American Zinc is a fully integrated producer and will smelt and market zinc from the new mine.



COMPUTERS are the answer

• For better operational control • For greater accuracy
• To speed calculations • To reach better decisions

Is your mine working at optimum capacity to get the longest and most profitable life from the ore body? As metal prices change are you prepared to make corresponding changes in your mining operations and mill circuits? Does your mill continually operate at top efficiency and lowest possible cost? Are your ore reserves calculations a matter of minutes?

If you can answer "yes" to the above questions, this copy of MINING WORLD may not be of much use. However, if you must answer "no," then read on. This special issue has something of significant importance for you—the value of electronic computers and how they can help you maximize profits.

A MODERN COMPUTER is a powerful new tool whose prodigious speed makes possible the solution of problems too complex and time consuming for ordinary human capacity.

A computer can evaluate more geological data in one year than geologists have handled manually in the past 150 years, and thus can multiply the effectiveness of exploration geologists by thousands of manhours per year.

A computer can be put to work on a mathematical model of an ore body to calculate the economic limits of open pit expansion, delineation of bench layouts, equipment balancing, and prediction of optimum mining conditions.

A computer can keep track of mining costs of various mining methods in various underground stopes, equate these with ore grades and metal prices to determine the maximum dollar recovery of an underground ore body.

A computer can be used to provide complete or partial automation for crushing, grinding, and milling a complex ore of varying grades, and assure continuous peak performance of the processing circuits.

However, the big advantage of a computer is the increased speed and accuracy with which management can obtain the information necessary to make sound and valid decisions. And properly used—with full knowledge of both its capabilities and limitations—a computer is economical, time saving, accurate, and self-checking.

WHAT IS A COMPUTER? The familiar image of 100 mathematicians with 100 desk calculators taking 100 years to solve some problem which the modern computer can do in one minute is completely true—if any thing, it is conservative. However, the computer is best defined in terms of its characteristics.

1. It is completely automatic. It can automatically perform mathematically operations, and repeat them as often as required.

2. It is very fast. The most modern computers can perform over 250,000 additions or subtractions, 50,000 multiplications or divisions in one single second!

3. It is complex. It can make logical decisions besides its mathematical functions. It can decide what particular data to use, where it is stored, and what operations to perform on it.

4. It is sophisticated. It can take problems and translate them into instructions which will later follow, determine possible errors, and check accuracy. Also, some units can start a second or third computation problem before the first one is finished.

Before a computer can solve any problem, that problem must be translated into terms the machine can understand and act upon. This is programing. Until recently this preparation had been a time-consuming tedious job which often took many weeks of work. And once the problem was in "machine language" the computer would produce the answer in a few seconds. Now however, automatic programing is cutting down this time considerably by letting the computer itself do most of the costly and time-consuming labor needed before a problem is ready for running.

ONCE A PROGRAM for a computer has been set up for a certain problem, this program, with only minor changes, is applicable to the same problem at other companies. Thus, a library of previously worked out programs has obvious advantages. Recognizing this situation, the United States Bureau of Public Roads in Washington, D. C., established an electronic computer program library in 1957. This library serves as a central point for the collection and distribution of computer programs developed for use in the highway field.

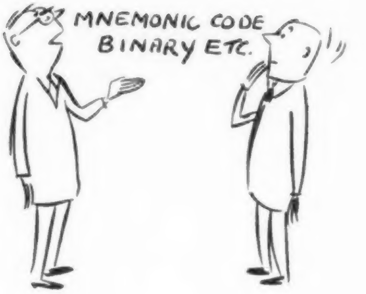
Taking a cue from the Bureau of Public Roads, the U.S. Bureau of Mines has begun to develop a library of computer programs applicable to exploration, mining, and metallurgical problems.

ALL SIZES OF MINES and metallurgical operations can benefit from high speed electronic computers. Today they are within the reach of both small and large engineering offices for helping solve the problems of design, analysis, and control. In mining offices where computer-sized problems are relatively few and intermittant, it is not necessary to purchase an expensive machine. Instead, the problem can be taken to one of the many computer centers located in all sections of the country. Computer centers are the latest phenomenon of our modern electronic age. They provide computer time and technical assistance in programming problems at a nominal charge in comparison to the work performed.

In addition to the computing centers there are also a number of private consulting firms prepared to provide complete computer services to the mining industry. The development of the computer program is done with complete security, and only the client has access to the results of the computations and the input data.

It would seem computers are here to stay. And so they should, since the potential uses of computers is limited only to the supply of mining problems. They are indeed a powerful new tool to provide more significant decision-making information than has ever been available before. END

Turn pages to find . . .



New Words For Your Vocabulary

To help you master the weird and wondrous language conceived by computer engineers, the following glossary will prove helpful.

If you would like to have a more detailed glossary of computer terms, write to Minneapolis-Honeywell Regulator Company, Data Processing Division, 2 Dorman Avenue, San Francisco, California, for a free copy of the booklet "Do You Talk 'Computerese'?"

ACCESS TIME—The time it takes a computer to locate data or an instruction word in its memory or storage section, and transfer it to its arithmetic unit where the required computations are performed.

ACCUMULATOR—A device which stores the results of arithmetic operations.

ANALOG COMPUTER—A computer operating on the principle of creating a physical, often electrical, analogy of the mathematical problem to be solved.

AUTOMATIC PROGRAMMING—A term for all techniques which are designed to simplify the writing and execution of programs.

BINARY CODE—A system of representing decimal numbers. Each decimal digit is represented by a combination of four binary digits (bits) as follows:

Binary code	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	0001	0000
Decimal code	0	1	2	3	4	5	6	7	8	9	10	

BINARY DIGIT (Bit)—In the binary numbering system, only two marks (0 and 1) are used—each is called a binary digit. The decimal number 296 converted to a binary number becomes 100101000, and it is made up of nine binary digits or bits.

BINARY SCALE (or numbering system)—A numbering system having rules much simpler than those of the decimal system. Where the decimal system uses ten marks (0 through 9) thus having a radix (or base) of 10, the binary system uses only two marks (0 and 1) thus having a radix of 2.

In the decimal system we think in "tens." For example, the number 35 means: $10 + 10 + 10 + 5 = 35$. Or it can be written as: $3(10) + 5(1) = 35$, or $3(10^1) + 5(10^0) = 35$.

In the binary system, we deal with powers of 2 rather than powers of 10. To convert the decimal number 35 to a binary number, first line up the various powers of 2 since 2 is the radix or base of the binary system. Above each power of 2 we show its value in a decimal number. Thus we get:

32	16	8	4	2	1
2^5	2^4	2^3	2^2	2^1	2^0

Remembering that in the binary system we have only two marks, 0 and 1, we then convert the decimal number 35 to a binary number as follows:

$$1(2^5) + 0(2^4) + 0(2^3) + 0(2^2) + 1(2^1) + 1(2^0)$$

The resulting binary number is 100011.

CODE—A system of characters and rules for representing information in a language that can be understood and handled by the computer.

COMMAND—A group of signals, or pulses initiating one step in the execution of a computer program.

COMPUTER—Any device capable of performing calculations, i.e., carrying out transformations of information.

CONTROL UNIT—The section of a computer that controls all information transfers and arithmetic operations in the computer.

DATA PROCESSING—A series of planned actions and operations upon information to achieve a desired result.

DIGITAL COMPUTER—A computer that uses numbers rather than physical quantities in processing data.

INPUT DEVICES—Machine units that read or sense coded data on a prescribed medium and make this information available to the computer.

INTERNALLY STORED PROGRAM—A sequence of instructions (program) stored inside the computer in the same storage facilities as the computer data, as opposed to being stored externally on punched paper tape, etc.

MACHINE LANGUAGE—The set of symbols, characters, or signs, and the rules for combining them, which conveys to a computer information to be processed.

MAGNETIC DRUM—Rotating cylinder surfaced with a material that can be magnetized. Used to store information in machine language.

MAGNETIC TAPE—Metal or plastic tape coated with a magnetic material which can store information.

MEMORY—A general term for the equipment that holds information in machine language in electrical or magnetic form. The word "memory" means storage inside the computer, while "storage" refers to magnetic drums, discs, cores, tapes, cards, etc., outside of the computer.

MICROSECOND—One millionth of a second.

MILLISECOND—One thousandth of a second.

MNEMONIC CODE—Instructions for a computer written in a form which is easy for the programmer to remember, but which must later be converted into machine language.

"MONTE CARLO" MATHEMATICS—A way of representing a complex phenomenon—such as the block caving abilities of different ores and rocks—as a game of chance. The "game" is played over and over again by the computer, perhaps hundreds of thousands of times, with the outcome giving a good indication of what would happen in the real situation.

OUTPUT DEVICES—Machine units that record or write information from the computer on cards, paper tape, magnetic tape, or as printed information on paper.

PROGRAM—Noun: A sequence of steps to be executed by the computer to solve a given problem. Verb: To prepare a program.

PROGRAMMER—A person who prepares the planned sequence of events the computer must follow to solve a problem, but who need not necessarily convert them into detailed instructions (coding).

RANDOM ACCESS—Equal time to all memory locations, independent of the location of the previous memory reference.

READOUT—The manner in which a computer displays the processed information. May be digital visual display, punched tape, punched cards, automatic typewriter, etc.

STORAGE CAPACITY—The amount of data that can be retained in the memory unit of a computer, often expressed as the number or words that can be retained.

ANALOG COMPUTER at the Computation Center of Electronic Associates, Inc., Los Angeles, California. This facility is similar to many computer centers in the world where industrial, scientific, and engineering groups can obtain use of the most advanced computing equipment, and the services of experienced engineers and scientists.

Why All This Fuss About Computers?

by **Ernest Koenigsberg**
Touche, Ross, Bailey & Smart
San Francisco, California

The popular press these days is constantly bringing us news items and feature stories about electronic computers. The claims often made are enough to make a manager feel that he will fall a victim of technological unemployment under the onslaught of these "mechanical brains," or be cast aside if he does not employ such equipment in his own business. We are not going to deny that electronic computers have had great influence in the business world, nor are we going to shrug off even greater computer-induced changes that will come in the future. Our purpose is to explain the nature and workings of computers and how they may be used to great advantage in business. Once these facts are understood, the manager can forget his apprehensions and get back to the basic job of "managing"—a job which no computer, past or present, can do!

Of the two types of computers in use today, the digital type is by far the most common and performs mathematical manipulations on numbers (digits) at very high speeds. The second type, the analog computer, is a device for setting up electrical network analogs of business operations (generally in the form of integral or differential equations) and obtaining answers by finding the solutions for the analog problem.

Digital computers

The so-called electronic brains are a collection of devices so wired together that they will perform tasks which can be performed by a moderately bright nine-year-old, for example: "add 2,025.27 to 17,650.43"; "subtract 2,925 from 4,025"; "subtract A from B, if the result is less than zero, then set B-A equal to zero"; etc. When you break down the clerical operations of most businesees, you find that they consist essentially of a host of tasks of the same form.

While computers can perform these tasks at fantastic rates (say from 5,000 to 1,000,000 such steps per minute) speed is not the only factor which contributes to their usefulness. Other important characteristics are:

(1) Computers are able to memorize or store large quantities of information which can be "recovered" quickly as needed for calculations.

(2) Computers can be organized or "programmed" in advance to perform many different tasks in proper sequence.

While it is true that the human brain serves the same functions, electronic computers need the creative power of the human brain, introduced by the programmer, to provide the logic to be used in performing a task. The computer then serves as an adjunct to the human brain, becoming a storehouse of data, rapid calculator, and handy index of instructions. Computers do not and cannot think for themselves. Skilled programmers are required to give the computer complete and specific instructions for each operation to be performed. Preparing these instructions adds costs which may be as large as the annual computer cost.

A digital computer consists of five major component groups:

Input: The information upon which the computer acts may be in the form of punched cards, paper, or magnetic tapes, typewriters (such as the Flexowriter or Teletypewriter). Newer forms of input devices include special handsets, information direct from cash registers or analog-to-digital converters, or from paper (such as bank checks) or card tags which can be read magnetically, optically, or electrostatically.

Memory: In general, input devices work more slowly than the circuits performing the actual operations. It is, therefore, an advantage to be able to store as much as possible of the information which is common to a number of calculations (e.g. for a payroll: a list of employees, their job classifications, tax classifications, pay schemes, and rates, etc.). A sufficiently large memory ensures that such information does not have to be re-entered in each separate calculation and thus increase the speed of the computer as a whole.

Memory devices currently in use include magnetic films, magnetic cores, transistors, cathode-ray tubes, vacuum tubes, acoustic delay lines, magnetic drums, magnetic tape, and magnetic discs. These have been listed in order of increasing access time, the time required to release information to the other circuits in the computer. The newer solid-state devices have increased computer speeds by a factor of perhaps 1,000; often computer speeds are limited by the size of the wires connecting the devices, i.e. the limit is the time to transmit an electrical signal (traveling at the speed of light) from one device to another.

Control: The control circuits put the mathematical operations into proper sequence and select the proper information from the memory. Most computers are "stored program computers," meaning that both the program (or sequence) and all the necessary information are stored in the memory units. Control information then goes directly from the memory to the control circuit. Other computers are internally wired to perform a given sequence of operations using both input and memory information. Some of the smaller computers rely on paper tape or punched card inputs to give the desired program. Some of the newer and larger machines can be programmed to perform several different calculations simultaneously.

Mathematical circuits: The mathematical circuits are the "heart" of the computer; they alone can manipulate the information to obtain the desired results. They incorporate either vacuum tubes or semi-conductor circuits, which operate in response to short electronic signals called pulses. Pulses are, in fact, the means of communication between all the components of the computer, and in the newest machines are extremely fast.

Output: Output devices are necessary to produce the information required by the user in a meaningful form and can take any of the forms used for input, or can be direct printers capable of printing up to 1,000 lines per minute. An output in tape or card language can be fed to an auxiliary system which prints the results without slowing down the computer. Sometimes output is desired in the form of cards or tape so that further sorting operations can be performed. This is particularly true when several reports based on the same output data are required.

The efficiency of a computer in dealing with any problem depends, to a large extent, on the knowledge and skill of the programming team. Computers communicate, both internally and externally, by using a code language. The programmer must convert all instructions and data into this language which, unlike the spoken word, is precise and 'single-valued.'

Programming is a taxing job and must make full use of the capabilities of the machine. For example, knowledge of the length of the access time of the various storage devices can be advantageously to reduce computer operating time. In recent years, there have been great advances in automatic programming languages, which allow the direct conversion of mathematical or business language to machine language (FORTRAN, COBOL, ALGOL, etc.) By simplifying the communication between the machine and the outside world, we do sacrifice some of the internal advantages of machine language (i.e. we generally lose some speed) but can often reduce the cost of programming a computer for a job by as much as a factor of 10.

Is there an advantage to be gained by using a computer in mining operations? The advantages may be direct and appear in lower net operating costs. Less obvious advantages, but probably more important in the long run, can be obtained if the computer gives faster and more accurate reporting at the same or even higher cost as is incurred at present, if it provides the manager with vital information previously unobtainable, or if it allows analysis of operations to obtain better guides for management decisions.

The earliest use of modern computing methods in industry was in scientific and technical applications. There are, of course, 'scientific' uses of computers which are of immediate use to management; they include 'Operations Research' as well as the direct applications to the mining industry.

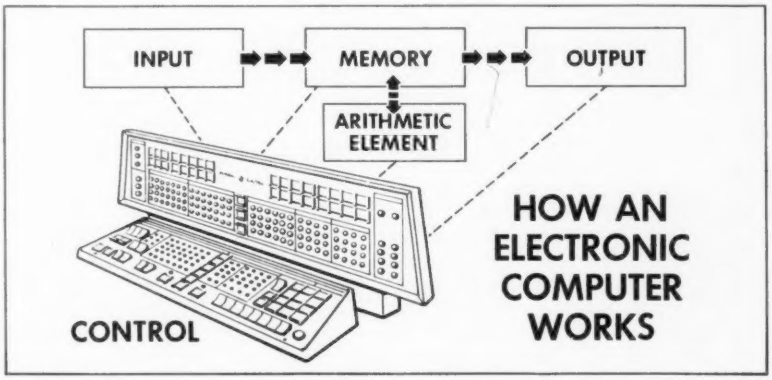
A computer can provide solutions to problems which are too difficult to solve, to sufficient accuracy, by any other method. Further, computers can provide answers to problems which may be too difficult even to formulate in mathematical terms. By reproducing the elements of the problem, it is possible to create a mathematical-statistical model of the system under study and to obtain trial results using the actual statistical distributions. This approach has proved useful in improving the efficiency of freight yards, terminals, mine haulage systems, and production facilities in the petroleum, metals, and chemical industries.

Analog computers

As the name implies, analog computers are devices capable of being made to operate as a model or representation of the system under examination. In this case systems are represented by an electronic network which is a model of the physical system. Many electrical plant control systems are in fact small analog computers which translate the feedback of information on the state of the system, calculate, and then send signals to activate control valves.

Analog computers consist of amplifiers and other net-work elements (diodes, impedances, etc.) which can be interconnected so as to represent a wide variety of systems. Given a large enough analog computer, one can set up a model of almost any system which can also be represented in terms of differential equations. The

continued on page 40



AN ELECTRONIC COMPUTING SYSTEM consists of (1) an input section, which reads data, or problems to be solved, in coded form; (2) a memory element, which stores this coded information, along with instructions for the computer; (3) an arithmetic element, which adds, subtracts, multiplies, divides, and compares numerical information; (4) a control section, which regulates the flow of information from input to memory, to the arithmetic element, back to the memory, and on to (5) the output section, a recording device such as a printer, control or signal.

PHILCO 2000 is first large scale all-transistor computer system that has advantage of asynchronous operation—the ability to progress from one operation to another almost immediately. This also permits advanced developments to be added to system at any time. Extremely high speed operation can complete 29,300 multiplications per second.

How To Make The Digital Computer

by **E. C. Dodge**
Manager,
Philco Western Computing Center
Palo Alto, California

Large electronic computers have often been referred to as "giant brains"—nothing could be farther from the truth. Actually, they are not capable of doing any thinking for themselves and must be told exactly what to do at each step, although they do these steps at fantastic speeds. This process of telling the computer what to do is called "programming." Since computers will only perform a rather limited number of different simple operations (such as add, subtract, multiply, divide, test for minus numbers, compare two numbers), a large number of sequential steps are required to accomplish the solution of a problem. A computer "program" is such a series of steps or "instructions" to the machine.

Before writing the program, it is necessary to determine just exactly what is to be done and how you are going to have the computer do it. A useful way of putting the problem into graphic form is the preparation of a "flow-chart." While it is not likely that anyone will use a computer to solve the problem of how to get to work in the morning, the flow-chart at right illustrates how the logical steps necessary to accomplish a task or solve a problem can be displayed.

After a flow-chart is completed, it is necessary to expand it into a list of detailed instructions to the machine. These must be in a language or "code" that the machine can understand and obey. This phase of programming is called "coding".

Let us consider an example. Suppose we want to add two numbers and store the result. The instructions to accomplish this, as well as the two numbers we wish to add, have to be in the computer's memory which may be thought of as a series of post office boxes. Like post office boxes each memory cell has a number for identification known as the "location" or "address." The capacity of each memory location is the same and is determined by the design of the particular machine. A typical size might be 10 decimal digits so that each location could hold a 10 digit number which represents an instruction used in the program. The memory cell capacity is known as the "word-length" of the machine, and each instruction or piece of data that occupy the memory location is known as a "word." When we get our two numbers added, we will have to assign an address in memory where we want to store the answer. Data is usually thought of as having an "address" in memory which is where we get it or put it. Instructions are considered to be in a particular "location" in memory. An instruction to the computer which is stored in some memory location consists of an "operation" (what you want the computer to do) and an "address" (where the data on which the operation is to be performed is stored).

Our program to add two numbers and store results might be:

LOCATION	OPERATION	ADDRESS
101	*13*	*6331*
102	*26*	*7417*
103	*37*	*3000*

This says that at Location 101 we have an instruction stored which looks like 0000136331 (assuming that we have a 10 digit word length machine). The operation code 13 means to "put the contents of address 6331 into the 'accumulator' of the computer." Since we had one of our numbers to be summed in 6331, we now have one of them in the accumulator. The computer then looks at the contents of Location 102 to see what is to be done next. Operation code 26 means "add the contents of the specified address to the accumulator," so obeying the instruction in Location 102 causes our second number which was in 7417 to be added to the first and we now have our answer in the accumulator. Proceeding to 103 we find that 37 means "store the contents of the accumulator in the specified memory address" so that when this instruction is completed we have stored our result in address 3000.

Digital computers are either decimal (as in the example above) or binary, in which case the only numbers that the computer can understand are written to the base 2. In a binary machine the instruction in Lo-

80 - COLUMN CODING FORM
TRANSLATOR-ASSEMBLER-COMPILER

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Program: AUTOMATIC TAPE ASSIGNMENT | Programmer: H. VOLIN | Checked by: L. T. GRIFFITHS | Date: 11 APRIL '61

IDENTITY AND SEQUENCE	L	LOCATION	COMMAND	ADDRESS AND REMARKS
ATA1029	L	ATACL	A/UTOO, C/JMP, ATA2 $	SET UP FOR MORE INPUT
ATA1030		SUT1	TJM	SUT1 $ PUT ASSIGNED TAPES IN SC. ATA
ATA1031			TMD	SUT2 $
ATA1032			TDXC	SUT2, 1X $ SYSTEM TAPE INDICATOR
ATA1033			TMQ	5/1T23 $ BRING IN MASK
ATA1034		SUT4	ETA	0, 1X $
ATA1035			JAEQ	SUT3 $ CHECK FOR UNASSIGNED TAPES
ATA1036			SRA	16 $
ATA1037		SUT2	TAD	SC. STI $
ATA1038			TDXCR	1N, 2X $
ATA1039			TMD	1/1 $
ATA1040			SRD	0, 2X $
ATA1041			DORMS	SC. ATA $ RESERVE ALL USED TAPES FOR LATER ACTION
ATA1042		SUT3	TMD	C/HLT, SC. LTI+1, C/HLT, SUT4 $
ATA1043			AIXJ	1, 1X $
ATA1044			TMD	SUT7 $ SET INDEX 1 TO TAPE TABLE LOCATION
ATA1045			TDXC	SUT7, 1X $
ATA1046	L		RPTA	16 $ RESET USED TAPE TABLE IN SYSTEM
ATA1047			TQM	1, 1X $
ATA1048			TMA	H/BAT47 $ REWIND COMMAND
ATA1049		SUT6	JQN	SUT5 $
ATA1050		SUT7	TAD	SC. TT $
ATA1051			TIO	0 $ REWIND ALL UNASSIGNED TAPES
ATA1052			NOP	0 $
ATA1053		SUT5	TMD	H/1T23, H/BAT47 $

CODING FORM filled out by programmer gives the operator complete step by step instructions as well as commands to feed to the computer. A large number of sequential steps are required to accomplish the solution of any problem.

Solve Your Problem

cation 101 of the example would look like 0011010011000101110ll. These numbers are fine for the machines but rather difficult for the human programmers, so programs are usually written in standard English letters, words and decimal numbers.

In symbolic programming language example might look like this:

LOCATION	OPERATION	ADDRESS
Add ores	*Load*	*Ore A*
	Add	*Ore B*
	Store	Mixture

Since the computer cannot understand this language, a translation has to be made into the machine's language. This is done on the computer by means of an Assembly Program which makes numeric storage assignments and translates operation codes. This Symbolic Assembly Program is quite complicated, but need only be written once for any particular model computer and is usually furnished by the computer manufacturer along with the equipment.

Steps involved in getting results from a digital computer

1. First, we must formulate and state the problem precisely.

2. Next a flow-chart is prepared.

3. Using the flow-chart the detailed program is written on coding forms, usually in a symbolic language, to be assembled or compiled.

4. The program is now prepared for entry into the computer. Since the machine cannot read our coding forms, the information is punched into cards or paper tape.

5. The input data that the program is to work with is also punched into cards or paper tape for entry into the computer.

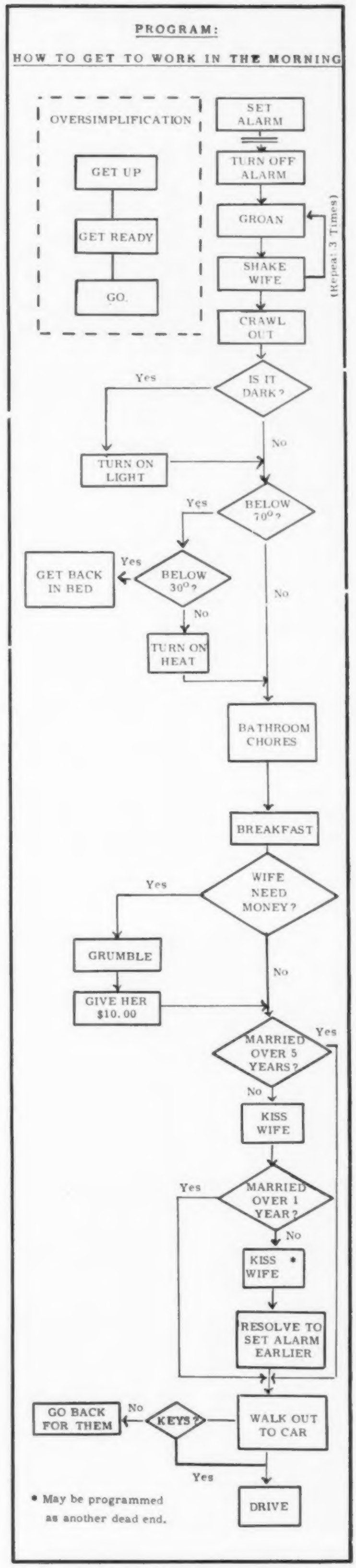
6. The program on cards or paper tape is read into the computer memory and using an Assembly Program or Compiler, a machine language program is produced which can then be stored on magnetic tape or punched out in cards or paper tape.

7. The data and the machine language program are now loaded into the computer memory and we are ready to run our program. However, usually we have made some errors in writing our program and it does not really do what we want. So now we have to "de-bug" the program.

8. Run the program on the computer and see what results we get. A test case with known answers is necessary at this point to determine whether the results are correct. Make the necessary changes and corrections, re-assemble and try again.

9. Run the "checked-out" program and produce our answers.

We are now in a position to run our program with different data or parameters with no further programming effort. We need only prepare additional input data to accomplish this. END



FLOW-CHART FOR A WORKING MAN

MINING EXPLORATION

—an operations research and simulation approach

Until recently, exploration phases characteristic of the mining industry have experienced little or no direct computer application. But, the computer should be considered a tool which is complementary to previously established exploration techniques and which extends their range of application.

Without reference to any particular industry, three distinct disciplines exist wherein the computer has proven utilization. They are: production control, systems design, and simulation. Simulation, when united with operations research is an effective aid to mining exploration.

by **Donald E. Pruss,** President, Geodynamics, Inc.
Santa Monica, California

and

Gerald W. Freeman, Vice President, Geodynamics, Inc.
Santa Monica, California

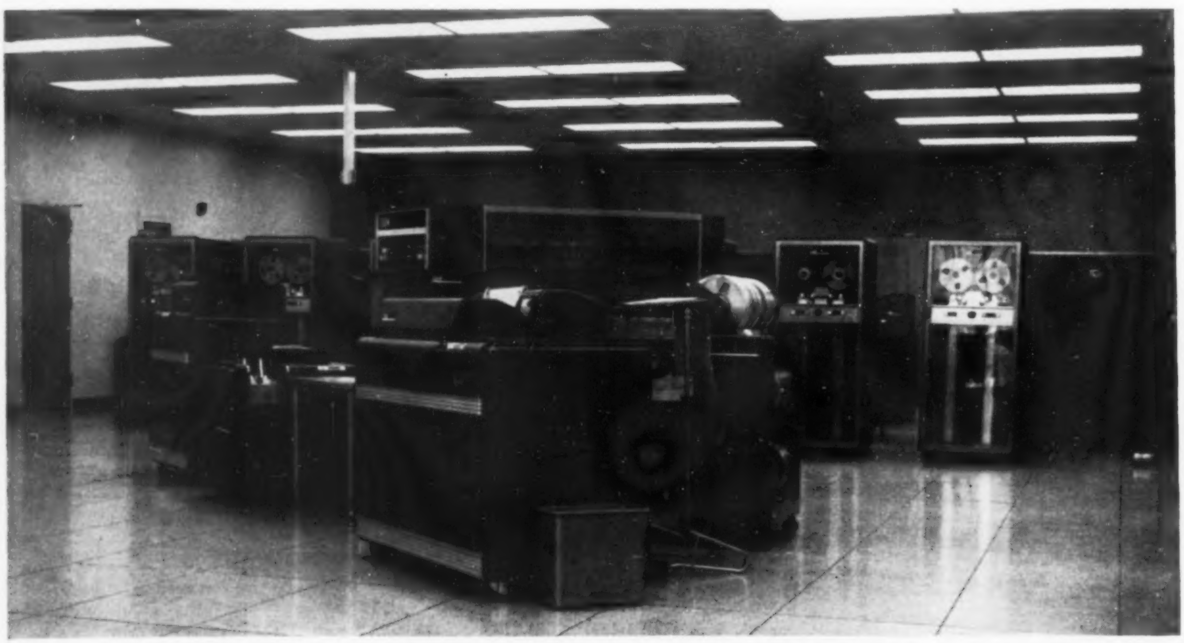
"OPERATIONS RESEARCH is the scientific approach to valuating alternatives under management control." Research into exploration processes is necessary in order to isolate the individual acts and systematically record their interrelationships in terms of a mathematical model. Once the system is thus defined it is possible to better inform the managers of the system as to the effect of a given decision.

SIMULATION is a substitute for experience and is undertaken to evaluate alternatives. Mining simulation requires three specialists: a geoscientist to assist in defining the problem; a systems engineer, mathematician or operations man to design a model; and a computer specialist.

Together they can design and implement a process which provides the ability to perform a particular operation in a computer wherein various alternate strategies may be tested for the optimum. A computer program can be said to simulate a real exploration program when it is able to respond to programed changes in a manner similar to what would happen to the real system under real conditions.

Statistical circumstances control benefits derived from mining exploration. The goal of every exploration manager is to maximize his success probability. Odds control lies in the optimum utilization of available data and search-location techniques. An optimum program can be determined through operations research and simulation.

Geological, geophysical, and terrain data may be recorded, compiled, and eventually correlated by analog-digital methods. The basic requirement is to refer map and chart data coordinates in space. Plotters can transfer data directly to digital form, storable on tape which can then be replotted at a later time, with any desired correlative data. For example, photogrammetric maps are correctable through transfer of precise hori-



IBM 7090 data processing system is adaptable to both scientific and commercial applications. Computing is simultaneous with multiple input/output operations under automatic control. The mathematical operations performed by a desk calculator in 80 weeks time can be more accurately done on this machine in five seconds.

zontal and vertical survey data such that a map can be automatically constructed which is correct in plan and elevation. Fairchild Aerial Surveys has a system of this nature.

There are many applications of the computer to geophysical data reduction and interpretation.

Exploration applications varied

Gravity: The computer has shown itself valuable for purposes of gravity data reduction and interpretation. The United States Geological Survey has programmed computers for gravity data reduction and derivative map development with most favorable results.[2] An example of this usage resulted in a net saving of 7.5 man years.[3] Information was available years ahead of that which hand methods would have allowed. Computers can greatly streamline the preparation of data for reduction. Expensive civil surveys can be avoided by computerized photogrammetric elevation determinations which cut at least in half the time necessary to gather field data.[4] The Humble Oil and Refining Company has programmed computers for geophysical map making and has shown that a small machine is capable of turing out a product in three hours which would take 15 man days for an equivalent product by hand.[5] Machines with greater storage capacities can do a similar job in minutes.

Before the advent of electronic computers, geophysical interpretation was sharply limited by the necessity to think in terms of simple geometric shapes. The computer has altered this limitation and now interpretation is possible for any arbitrary shaped body.[6]

Magnetic: All the possibilities presented for the gravity technique apply equally well to magnetics. The computer is even more critical in obtaining interpretations from magnetic data than it is from gravity data in as much as the phenomena of magnetism is more complicated.

Electromagnetic: Programs are being considered to handle electromagnetic data which will make available another potent tool for the location and analysis of mineral deposits. Techniques such as those discussed above indicate the capability of modern data processing systems with modern data gathering systems to provide a new key to the problems of resource development so acute in the world situation of today.

Property evaluation and appraisal

Economic appraisal determines 1. what is the areal distribution of expected deposits, 2. what is their distribution according to value, and 3. what is the expected cost of location and evaluation and hence profit-ratio.[7] Simply, the attempt is to reduce the risk to the uncertainty in search and equipment abilities.

MODERN RESOURCE ANALYSIS requires advanced techniques for accurate evaluation, and the electronic computer is one of the most useful tools available to engineer and scientist. Shown is the 120 column printed output of an IBM 7090.

Statistical appraisal studies have been performed for regional sized areas to indicate the mathematical laws of distribution of mineral deposits which are applicable to operations research and simulation programs. One such study by Dr. T. B. Nolan[8] determined that the distribution of values according to production from 285 mining districts in the Basin-Range area follows a log-normal distribution. Other analytical studies by earth scientists have helped establish the probabilities of locating reserves in new areas. Such studies are exemplified by Allais's[9] work in the Algerian Sahara Desert and that of Slichter[7] with reference to North American exploration. Allais determined that for areas of 1,000 to 10,000 square miles, mineral wealth has a Poisson distribution. Slichter's study indicates that the probability of locating new reserves in any given area is independent of the already existing mines or reserves. The implication is that locational difficulties, not absence of targets prevents locating new mines. These studies form a basis for rational exploration programs utilizing techniques as described in this article.

Statistical analysis is also the most important method of determining average and cut-off grade for deposits wherein the ore changes gradually from rich to poor. It has been shown that tonnage increases at a constant geometric rate as grade decreases.

The principal reason for making such statistical analyses as the frequency distribution, the mean, the median, the average deviation from the mean, the standard deviation, and confidence level is to determine the number of samples, drillholes, etc. which are required to adequately evaluate a deposit, or to plan a sampling program, or in general to aid management in decision through more accurate grade control.

A mineral operator wishing to extend his reserves might proceed in several ways. He could either search for blind extensions and neighbors of the ore body he is presently working or he might consider lowering his grade cut-off point. Regardless of the way in which he proceeds he must acquire information about the rock materials in the region in which he is interested. A powerful technique for doing this is through the use of geophysics.

Geophysical instruments have become widely accepted for locating unknown mineral deposits through exhibition of subsurface variations in mineral content. A sharp change in the reaction of the instrument is taken to indicate the presence of a mineral deposit. However, much of the information about the mineral deposit; its size, shape, position, and grade—hidden in the data obtained by the instruments—is not used. It is theoretically possible to obtain this information but because of the laborious calculations involved, only very seldom have complete interpretations been attempted. The development of the automatic digital computer makes possible extensive and elaborate interpretations of geophysical data. Computations can now be handled automatically at rates of hundreds of thousands per second.

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Computers Have Application to

Complexity of open pit and underground mines makes possible application of digital computers to the solution of many problems. Obvious applications of computers for most mines are to the following broad areas: (1) ore reserve and inventory computations; (2) cost and equipment analysis; (3) production scheduling; (4) development and mine planning; (5) haulage; (6) surveying; and (7) routine or general calculations.

Information from one area of application is used in many others, particularly starting with the ore reserve data.

Four common methods of computing ore reserves are the statistical, polygonal, triangular, and the cross-sectional. Punched card machines and computers have been used by many companies for making ore reserve estimates using all methods.

Oliver Mining Company has their computer make some ore reserve calculations. The computer is used to: (1) average drill-hole assays for each cross-sectional area; (2) weight grade with the areas; (3 cumulate tonnages and yardages previously calculated; and (4) calculate the combinations of tonnage and grade.

Kaiser Steel Corporation utilized a punch-card machine for computing tonnage and grade for their Silver Lake iron deposit and the east pit of the Eagle Mountain mine. Calculated for ore and waste were: (1) summation of assay data; (2) summation of drill-hole data for each cross-section; (3) summation of sectional data for each ore body; (4) summation of ore body data for the total deposit; and (5) summation of ore grade for seven elements in the total deposit.

Digital computer programs for computing ore reserves as developed by the author can consider the following computational variables for open pit or underground mines: (1) varying tonnage factors; (2) uneven assay intervals; (3) any grade cut-off point(s); (4) any reference elevation(s); as pit benches, pit bottoms, ore blocks, levels, etc.; (5) numerous minerals per sample; (6) different boundary lines for the deposit (property, geological, or proposed pit limits); (7) irregular areas on mine maps or cross-sections; and (8) any vertical drill-hole or deposit interval.

The digital computer

STATISTICAL METHOD of ore estimation only

Statistical analysis of drill-hole data to estimate average grades of a mineral deposit considers only the assay values and usually not the volumes which they represent. Therefore, assays are not commonly weighted with volume. Necessary concentrations of drill holes in certain areas add a bias to the statistical estimate of mean or average grade. This bias can be corrected by averaging the drill holes so that only one drill hole is located within a constructed square grid laid over the drill-hole plan map. In many cases, a simple computer program would be useful to re-average drill-hole assays in some of the grid areas.

The effect of grade trend (three dimensional) on average grade of

POLYGONAL METHOD assumes that the area of

The polygonal method of calculating ore reserves is based on the assumption that the area of influence of each drill hole extends halfway to the neighboring drill holes. Thickness and grade must vary uniformly in opposite directions for errors to tend to be compensating. Where thickness and grade vary in the same direction the errors will accumulate.

Area of the polygons can be determined by three methods; using a planimeter, data reduction equipment (Oscar record reader), or by using the coordinates of the surrounding drill holes. Computer programs have been written to use all three methods.

The following are computed, either per polygon or for the entire

TRIANGULAR METHOD assumes a direct linear

The triangular method is based on the assumption that within a given triangle a linear relationship exists between the grade difference and the distance between adjacent drill holes. In deposits with erratic mineralization, this relationship is anything but linear.

Input data for the triangular method computer programs are the same as for the polygonal method and consist of survey cards and then assay cards. The only difference is that the data from the three drill holes that form a pre-determined triangle must be assembled in sequence. The computer reads in three drill-hole data sets and uses these to make the computations for that triangle. The calculation of area for tri-

CROSS-SECTIONAL METHOD projects all data to

Assays and other data are projected to predetermined planes and the areas of influence of the assay data are determined mainly by judgment. This method is helpful not only for ore reserve computations, but also for mine planning. Computer programs are used to: (1) average drill-hole analysis for each cross-sectional area; (2) average the interval grade by weighting the grade with the volume of the interval; (3) cumulate tonnages and yardages and the respective grades; (4) sum all combinations of tonnage for various grade class intervals; and (5) calculate areas of irregular surfaces on maps or cross sections (electronic planimeter).

Costs—Data reduction (Oscar); about \$0.025 per point. Computer area program: about \$0.003 per point.

Ore reserves were computed with

Many Mining Problems

by **Richard F. Hewlett**
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Tucson, Arizona

is ideal for ore reserve calculations

considers assay values and not usually the volumes they represent

certain grade classes (as ore, leach, direct smelting, direct shipping, etc.) can be compensated for by stratifying the assays according to numerous grade cut-off points. Likewise, any desired vertical interval can be analysed, such as certain benches or other mine depths. Simple computer programs can be used to punch out assays from desired vertical intervals, benches, or any other areas of the mine. This punched-card assay data can then be analysed statistically with the following computer programs: (1) mean or average of any grade class interval; (2) standard deviation for any grade class interval; (3) standard error of the mean for any grade class interval; (4) log classification (frequency table) for log-normally distributed data (assays); and (5) frequency of occurrence for any grade class interval (by coding). There are numerous statistical computer programs that are "canned." List of available programs can be obtained at most computer centers. Computer costs are from $2.00 to $5.00 per 1,000 assays.

influence of each drill hole extends half-way to the next drill hole

deposit: (1) polygonal tonnage and grade; (2) cumulative summation of tonnage and weighted average grade; (3) tonnage and grade (per polygon and cumulative) for special classes of material; (4) tonnage and weighted average grade for 40–0.1 grade class intervals; (5) total tonnage for any (of the 40) cut-off grade intervals; and (6) average grade for any (of the 40) cut-off grade intervals.

Costs—Data reduction cost (Benson-Lehner Oscar E): $0.25 per polygon; total cost for 127 polygons was $31.87.

Separate computer program to calculate area of each polygon from output of Oscar E: $1.75 per 100 polygon; total for 127 polygons 52.22.

Computer computational rate and cost: Per polygon output is 8.3 polygons per minute or $0.07 per million tons; total cost for 127 polygons was $26.60. Entire deposit output of 2,300 polygonal prismoid calculations and summation of tonnage into 40–0.1 grade class intervals in five minutes; total cost for 2,300 polygonal prismoids was $10.00

relationship between grade difference and distance between drill holes

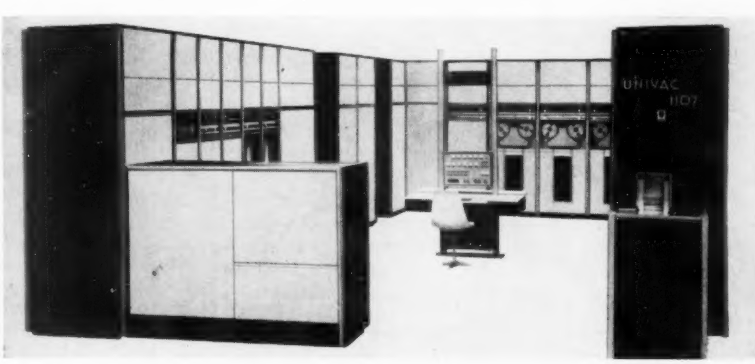
angles formed by irregularly spaced drill holes is performed by using the coordinates of the drill holes and then by calculating the volume of the triangular prismoid for any predetermined vertical interval. Five computer programs have been developed that are modifications of each other. Three methods are used to calculate volume to account for: (1) undulating topography; (2) different triangle configurations; and (3) effect of pit slope and limits on volume.

Output for each triangle or the entire pit are: (1) total triangle tonnage and grades calculated by three methods; (2) cumulative summation of triangle tonnages and weighted grades for different grade classes; (3) tonnage and grade for (numerous) 0.1 grade class intervals; (4) tonnage for different 0.1 grade class intervals; and (5) average deposit grade for different 0.1 grade class intervals.

Costs—punched-card data assembly cost: 4.8 triangles per minute or $2.70 per million tons; total cost for 250 triangles was $72.90.

predetermined planes

the previously mentioned computer programs for a mined-out portion of the Silver Bell oxide pit at Silver Bell, Arizona.



UNIVAC 1107 of Remington Rand is a thin-film memory computer with the fastest memory form yet developed. Access time of computers previously had been rated in terms of microseconds. The need for faster solutions called for a faster memory speed. This is provided by the magnetic thin-film memory with a speed rated in billionths of a second.

UNDERGROUND MINING applications include

Methods of data compilation, classification, and calculation have to be developed by most mines that can be automated by business machines. For ore reserve classification, commonly used variables are: (1) mineral type and assemblage; (2) rock type; (3) mining cost; (4) production schedule; (5) base price of mineral; (6) amenability to present mill circuits; (7) cost of changing mill circuit for the ore; (8) haulage distance to the mill; and (9) haulage distance to the smelter.

These variables can be considered when processing the data with business machines and/or computers. Study of such problems as ore control, ore recovery, geological implications of the data, tonnage excavation, etc., can then be made quickly with the existing punched data.

Waste today could be ore tomorrow

Many open-pit mines maintain ore control with blasthole assays plotted on bench maps. Areas of waste and grade classes of ore are marked or flagged in the pit for proper segregation of materials. Location of the shovels are determined by the mine supervisors. Some open-pit uranium mines build stockpiles with a grade range of about 0.03 per cent U_3O_8. It is important to know the grades accurately because waste today could be ore some day. Underground ore control is similar, with many types of assays being used for ore control purposes. Objectives of ore control are: (1) to blend ore to a desired grade; (2) to blend minerals to a desired proportion (as oxide-sulphide); (3) to determine the grade; and (4) to minimize cost.

Oliver Iron Mining Company uses their computer in recreating and simulating conditions of gathering and shipping iron ores. This technique has been used to demonstrate the possible effect of various modes of handling and blending ore on the uniformity of the various ore grades they supply.

Riverside Cement Company uses their RW-300 process-control computer to calculate the amounts of available materials that are required for cement. Costs of each raw material, constituent analysis, and range of oxide analysis are the input used for the computer solution.

An example of solving production scheduling problems using linear programming and a computer solution is shown for 10 bauxite deposits. Each deposit has a different location, tonnage, grade of silica and alumina, and consequential mining cost. A plot of cumulative cost per ton against deposit tonnage for various production rates is shown in Figure 1.

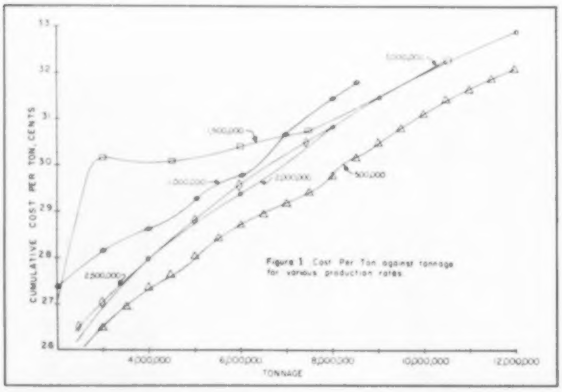


FIGURE 1 shows cost per ton for various production rates.

Pima Mining Company utilized a computer to determine the economic limits for their pit expansion program. In a maximum time of five days, one man obtained all the information with the use of a computer, while it required about 60 man-days before.

Oliver Iron Mining Company uses a computer for calculating traverse closure and other survey calculations.

Union Carbide Nuclear Company used a digital computer for survey calculations. Problems worked on were: (1) solving traverses closing on starting point; (2) solving traverses which close between two unknown points; termed open traverses with balancing; (3) solving truly open traverses which have no closing point; and (4) solving elevations and coordinates of stadia shots. An IBM 704 digital computer was used. The rental is $6.00 per minute, but in this minute the computer can perform computations two surveyors would require 120 man-hours each to make.

Reported cost of calculating a stadia shot by manual means was approximately $1.00. Total computer and key punching costs are $0.36. Manual calculation cost per traverse station is $2.50 compared to a total computer and key punching cost of $0.36 per station. The cost of surveying and computing a drill-hole location was in excess of $6.00 per drill hole manually. Use of computers for the computations reduced the cost to $2.00 per hole.

About 50,000 mine-sample assays were processed by Koch and Link in a preliminary investigation of the distribution of gold, silver, lead, copper, and zinc from the Frisco and Fresnillo mines in Mexico. Cards were punched directly from level maps, longitudinal sections of stopes, drift maps, and cross sections of raises.

Calculated or determined were: (1) vein content at each location; (2) combined basemetal assay; (3) approximate sulfur assay; (4) silver-zinc ratio; (5) lead-zinc ratio; and (6) combined base metals content. For calculating the contents of the five metals at commercial rates this step would cost about $0.25 per sample.

Additional applications to mine operations are:

1. **Routine reports.** These could contain such information as sample numbers, widths, assay values and locations, metallic content, content adjusted to minimum stoping widths, dollar values, sub-totals and grand totals for assays from various working places, averages, and assay lists.
2. **Calculation of ore reserves.** These could facilitate location of ore shoots.
3. **Readjust ore block limits whenever metal prices or liquidation values change.** Reblocking would also be used to control stoping and make decisions concerning the economic time to shut down the stope.

Companies using punched card machines for ore reserve calculations include the Cerro Corporation, The Anaconda Company, Homestake Mining Company, and many others that are unreported. The Sullivan mine in British Columbia has been calculating ore reserves with their punched card calculating machines since 1948. They also use their accounting machines to store and classify large amounts of data concerning the mining characteristics of each reserve block, as well as tonnage and metal content. This information is used for long-range planning, in forecasting production schedules, and in analyzing the results.

Homestake Mining Company is doing a mining simulation study of its uranium operations to maximize profits by determining ore schedules. They want predictions for tonnage, grade, and profit.

K. F. Lane of Rio Tinto Mining Company of Canada has developed a method for determining the optimum

planning, haulage and equipment utilization

strategy for mining an ore body. The solution is expressed in the height of work and distances of advance from each drift. The model takes into account development costs, mining costs, transportation costs, and the subsequent costs of crushing, grinding, etc.

Mathematical model usually simplifies problem

Constructing a mathematical model of the operation (or a segment of it) so that other information becomes available as a fringe benefit is an economical and time saving manipulation.

A mathematical model has been developed by the author that can consider: (1) requirements of a specific mill; (2) a large number of mines; (3) different tonnages and mineral grades per mine; and (4) any pertinent costs. This model would be useful for helping to determine optimum production schedules and mineable reserves for underground mines with different thicknesses of ore where mining cost is closely related to the thickness of the ore.

A mathematical model has also been constructed and solved with linear programming so that the following are determined: (1) optimum location of hoisting shaft(s); (2) optimum location of working areas for production schedules; (3) production schedule for the mine; and (4) tonnage to be mined from each working area for any desired cost of grade cut-off point. Each working area can, in turn, be divided into headings and considered in the same model or in separate models.

A simple solution to the model would involve obtaining separate solutions by linear programming for different locations along the main haulageway and analysing the results. If the ore reserves for each working area were nearly the same, the hoisting shaft would be located near the center of mass of the mineable limits of the deposit, all other things being equal. The usual case would be for different ore reserves and mineral assemblages to be in each production area (stope). Analysis of the results obtained for different locations would help to determine the location of the shaft that would: (1) require the minimum start-up costs; lowest capital investment; and (2) result in maximum deposit utilization (total tonnage) at a minimum cost.

After the shaft location has been decided upon, information available from the results are: (1) equipment requirements and data for equipment utilization studies; (2) most desirable production rate; (3) basic data for other cost estimates (life of the mine, operating cost, and capital requirements); and (4) basic data for selecting or improving the mining method (selective or nonselective). Selection of more than one shaft could be treated in a similar manner. Likewise comparisons of the attributes of various shafts can also be performed.

Simulating mining conditions ups efficiency

Many other types of development problems can be solved economically with the use of a computer. For example, some highly erratic ore bodies contain numerous mineralized beds and barren beds. Whether numerous beds should be mined together or separately could be resolved into an economic problem. The ability of a computer to make many computations that would allow comparisons of the mining methods of their consequential costs would prove time-saving and economical.

Computers have been used to simulate numerous underground mining conditions and equipment. The purpose of making equipment utilization studies is simply

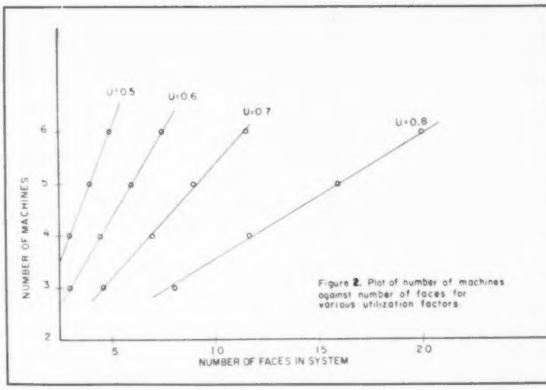


FIGURE 2 shows utilization factors for machines.

to achieve higher efficiency and lower costs. Increasing section output is a measure of productivity used to achieve these goals. The first step in increasing output is to represent the operations by the mathematical model.

Data required for a model are: (1) map of mining area; (2) knowledge of mining plan; (3) number of working faces; (4) number of machines; and (5) types of machines used and their average operating times.

An underground coal operation can be considered to illustrate the solution of the model. Because there is a waiting situation created by the different types of machines at the faces, a sequence waiting line is formed. Queuing theory can be used to solve the model of the relationship of the machines and working faces. In some cases, Monte Carlo techniques would be applicable.

A production unit was simulated with from 3 to 6 machines (**M**) and from 3 to 20 working faces (**F**). Average service time for each stage (**t**) is about 1.00.

Figure 2 shows the relationship between equipment utilization factor and number of machines and working faces. Costs could be plotted on this graph for determining economic break-even points for estimating the optimum number of faces to be worked for all production units.

It can be observed that maximum utilization is obtained when the number of machines and faces is the largest. When either the number of machines or faces is fixed, the other can be determined in accordance with the mining plan, safety restrictions, and many other factors. These data could then be used to make a model of the numerous working areas, and their production potentials, and optimum production schedules determined for all production units in the mine by linear programming. This would allow equipment, mining, transportation, maintenance, and other costs to be considered.

Objectives of the simulation are to: (1) reduce loader waiting time due to increased shuttle car travel time; (2) increase loading rate; (3) reduce delays due to handling supplies; (4) reduce the effect on production of breakdowns; and (5) provide higher total production.

Complex haulage problems are common in any operations. Kiruna iron mines in Sweden has a "Transport Brain" computer that: (1) directs trains from loading pockets to the most suitable unloading or crushing point; (2) switches and locks the switching points; and (3) supplies red and green lights. Maximum safety, time saving, and cost reduction are reported to result. **END**

Using the COMPUTER for metallurgical problems and process control

by **Lawrence J. Prince,**
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Colorado School of Mines, Golden, Colorado

The use of computers in metallurgy and process control in all but the large companies has been hampered in the main by computer costs. Now however, several applications are possible with the new small-sized, medium capacity computers that rent by the month in the $1,500 to $2,500 range or sell outright for $50,000 to $75,000.

These medium-capacity, general purpose computers, once installed in a company, are soon running around the clock on a great variety of problems. In metallurgy the problems are described mathematically by such terms as analysis of variance, curvilinear regression, curve fitting, matrix inversion, linear programming, and transportation problems. Such terms tend to scare off the uninitiated in computer language, but for the most part, problems involving these terms have all been programmed and the programs are in the computer libraries.

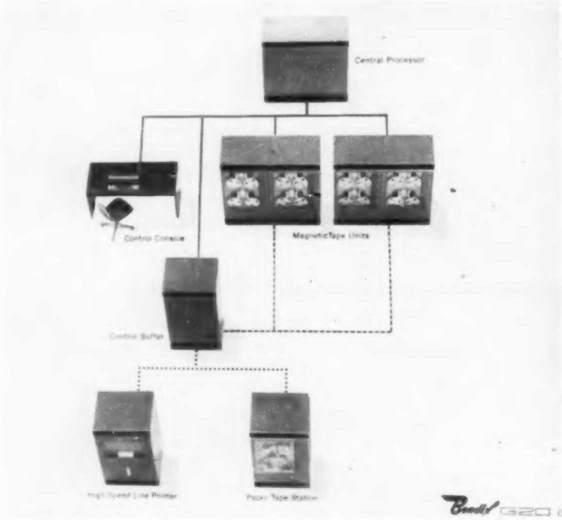
Leaders in the field of metallurgy and process control have been the large companies, but the methods they have been using on the large-scale, high-cost computers are now possible for smaller companies using the medium-sized computer. Riverside Cement Company has used and is using computers for blending and mixing cement raw materials for maximum dollar recovery. Jones and Laughlin Steel Corporation is using computers in process control to eliminate guesswork by calculating the proper proportions of molten iron, scrap, and lime. GPE Controls, Incorporated is using a computer to control open-hearth operations and a sintering plant. United States Steel Corporation is using a computer in problems involving correlation analysis, linear programming, transportation problems, machine loading, queuing theory, production, and inventory. The Colorado School of Mines Research Foundation is using a computer to solve the systems of equations resulting from concentration processes and various statistical analyses of observed experimental data. The U. S. Bureau of Mines is using a small computer on pyrometallurgical research problems.

Linear programming techniques used to greatest advantage

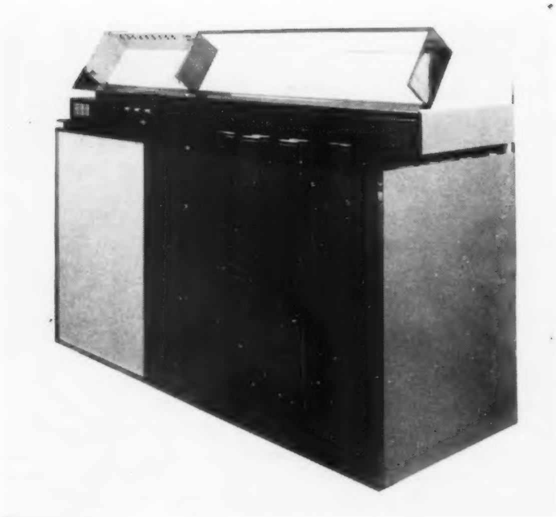
Most metallurgical applications of computers involve mathematical techniques with which many engineers are not familiar. However, this should not rule out the computer as a tool, since use of the computer and its library does not depend heavily upon familiarity with these techniques. A brief description of some of the more common techniques follows:

Correlation Analysis: An estimate of a variable based upon observations of several variables involves correlation studies or a study of how the variables depend upon one another. Statistical formulas designed to give insight into these correlations involve tedious and repetitive arithmetic. Most of the formulas have been programmed for computers and these programs are in all computer libraries.

Linear Programming: Of all the mathematical techniques used in metallurgical and process control applications, probably the one used most often and to the greatest advantage is the one called "linear programming." To those not familiar with the technique the name is misleading in that it is assumed to be a computer programming method. Actually linear programming is intimately connected with the theory of games. One of the first applications was what has become known as the "transportation problem." This particular application is being used now in the minerals industry. The original problem dealt with a manufacturer with a number of warehouses and factories. The manufacturer knew the cost of shipping a product to each warehouse from each factory, and he wanted to arrange shipments so as to minimize the total shipping cost while making sure that no warehouse would exceed its capacity. An obvious application in the mineral industry would be shipments from several different mines with the various restrictions including such things as depletion of reserves.



BENDIX G-20 general purpose computing system uses unique control buffer to direct input/output allowing essentially unlimited versatility of communication between units.



LIBRATROL-500 by General Precision, Inc. receives incoming-data from monitors, and after processing, provides control information for operator or automatic instruments.

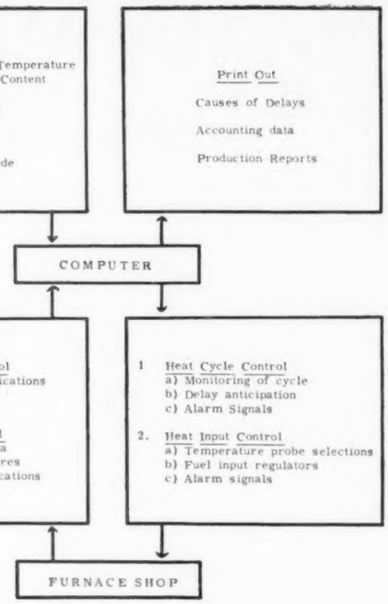


Figure 1

Problems of a Repetitive Nature: This class of problems is where the versatility of the digital computer saves a company many hours of tedious labor. The following example was performed by the U. S. Bureau of Mines pyrometallurgical laboratory with an overall time saving of 80 percent.

The problem was to calculate the heat content of pure iron at intervals of 5° F. over a range of 0° to 3,000° F, taking into account the phase changes and change of state that occurred. Five estimating equations relating temperatures in degrees Kelvin to heat content in calories per gram-mole were stored in the computer. Each of the 601 calculations involved transformations of integral values of Fahrenheit temperatures to fractional values of Kelvin temperatures, selecting the proper equation for the temperature, calculating the answer, and expressing it in BTU per pound instead of calories per mole before printing the results.

No data were needed for the above example in that the computer started calculations at 0° F, and then automatically incremented by 5° F. until finished. This technique can be used on many repetitive problems, eliminating the necessity of large volumes of data.

Curve Fitting: Most computer libraries have a general purpose least-squares curve fitting program. This program may be used to fit data to various types of curves if the type is known. If the type is not known, because of the rapidity of the machine, experimentation with different types may be made until the correct type is discovered. A typical example would be one involving unsteady state heat losses to furnace walls.

Much confusion and differences in opinion are prevalent in industry on the justification of computers and the methods of their application to process control. Limited control of processes have been attained in the past using various forms of computers, i.e., analog, special purpose digital, and now digital. In the future the optimum system will probably be a combined digital-analog system.

A typical example of the use of an on-line digital computer is the one being made in the manufacture of steel by the open-hearth process.

Figure No. I is a block diagram representing the connection of an on-line digital computer with an open-hearth furnace shop. Usually several furnaces are in operation at one time but operating independently of one another. With the computer on-line in the process, several heat programs may be stored on the memory unit and reference to them made at selected times. Therefore, one of the computer outputs to the process is "heat cycle monitoring." By noting elapsed time intervals periodically on each furnace, the computer can give warning to the operator of approaching delays. The other computer output to the process in Figure No. I, refers to the control of temperature scanning and BTU input rate. That is, if temperature probes are located in the area of highest temperature in the furnace, a scanning and feedback loop can be used to control the flow of fuel to the furnaces to insure desired BTU input rate without damage to the furnaces.

Process control applications are varied

Great progress is being made in the development of digital computers. As they become faster with larger memory units, their use in scientific computing will grow. Many process loops have characteristics which lend themselves to non-linear control, particularly those with short time constants. Therefore, a higher level of control can be realized with on-off control systems. The end control element can be a simple on-line analog device which the programmed off-line digital computer can control. This system will require a two-way digital-to-analog converter but these are now becoming available for most general purpose computers.

The process control system of the future will probably contain an analog form of some plan of operation. Analog transducers will measure in real time the results of physical operations. This information will then be evaluated with respect to the technical plan as well as the economic and market tactics, using combined analog and digital processors. Exceptions to the plan of operation will be displayed to human managers through various output devices and new data inputs will be dictated. END

SMALL MINES
can make wide use of computers

by **Richard F. Hewlett**
Computer Consultant
Tucson, Arizona

The applications of computers to problems of small mines or mineral deposits fall into two categories: initial evaluation and production applications. A good example of this is afforded by the recent development of a small mine in Arizona.

Mineral deposit X was outlined by about 20 drill holes. Three minerals were present, one of which affected the mill recovery. It was decided to evaluate the deposit utilizing a computer for the calculations when economically feasible. Drill hole data were punched onto standard 80 column cards. A feasibility study was made, and it was determined that all calculations could be made with a computer. The surface geology was mapped and studied by the company evaluating the deposit.

Steps taken in the first phase of the computer evaluation of the deposit were: (1) construction of polygons, rectangles, and triangles on a plan map; (2) construction of some sections for geological interpretations; (3) consideration of geological factors that affect the mineralization; (4) drawing of geologic factors on maps (plan and cross-sections) and judgment corrections were made to the areas for drill-hole area continuity; drill-hole area of influence was modified by geology; (5) computational variables were determined: (A) tonnage factor(s); (B) reference elevation; (C) grade cut-off's; and (6) computed ore reserves by the triangular, polygonal, statistical, and cross-sectioned methods.

Ore reserve computations were compared and decided upon. Reserves computed by the various methods were in general agreement, but gross disagreement occurred in some areas. A compromise was made in certain areas and the deposit divided into 10 working areas. Ore reserves were computed for each working area for 40 grade class intervals of 0.10 percent. Tonnage and grade was determined for each 0.10 percent cut-off as a rough guide in selecting the economic cut-off for the mine.

PB 250 by Packard Bell is one of the smallest high speed digital computers available. In this desk-side model both data and commands required for computation are stored in a homogeneous memory. Maximum operation rate is over 40,000 instructions per second, and a 22 bit square root problem can be completed in only 252 microseconds. Cost $30,000; monthly rental $1,000.

An estimate of the mining limits was made from the results of the ore reserve computations. A maximum mining limit was then determined.

Some calculations were made to compare mining costs of underground and open pit methods. Stripping ratios were calculated for various pit slopes, and it was determined that mining by open pit methods would be more expensive than mining by underground methods.

An appropriate underground method was selected. Mining of the ore body would be done with only a few levels.

Development and production

The next phase of the evaluation involved determination of production schedules for the life of the mine.

Each of the 10 working areas (stopes) was divided into from 14 to 20 increments of advance. Location and size of the increments was determined according to the mining plan. Each increment of advance was expressed by: (1) tonnage of the increment; (2) grade of minerals A, B, and C for the increment; and (3) development and mining costs for the increment. In addition, increment availability for mining at time intervals over the expected life of the mine was determined so as to conform to the development rate; driving drifts, cross-cuts, raises, etc.

Cost data were estimated and some calculated with other computer programs. Wages paid in the area were averaged by a least error computer program that mathematically fits a curve to the numerous points on the wage graph. Development and mining costs were also calculated for various parts of the mine. Factors effecting mining and development costs were: (1) distance from the shaft; (2) thickness of the ore; and (3) production (rate and total).

Mill requirements were specified for: (1) maximum percent of mineral C; (2) minimum ratio of mineral A to B; and (3) minimum and maximum production rates.

The computer "mined" the entire deposit with numerous production rates within the range dictated by the mill. At the same time, the location of the hoisting shaft was

HONEYWELL 800 by Minneapolis-Honeywell Regulator Company is a transistorized model featuring an optimum word length, expandable magnetic-core memory (4,096 words to 32,768 words), high-speed magnetic tape units (peak transfer rate 96,000 decimal digits per second), and a wide range of both on-line and off-line input-output devices.

changed to determine the optimum location of the shaft for the various production rates.

Determined from the series of computer runs were: (1) optimum production rate (per month); (2) production schedule for the mine per planning period for the life of the mine that satisfied the mill and cost restrictions; (3) mineable tonnage of ore for: (A) various labor costs; (B) various metal prices; (C) other cost fluctuations; (D) different production rates; (4) economic grade cut-off points per stope for: (A) various costs; (B) various tonnages-production rates; (C) mineral percentage fluctuations per stope; and (5) equipment and labor required for determined production rate.

Some side problems that were resolved to economics were also solved. By using the computer for the computations described, a large amount of information was obtained from the exploration drill-hole and cost data. Use of a computer for the evaluation insured precision in the calculations and more elaborate methods were utilized in the evaluation in a short period of time. Solutions were obtained in the evaluation for ranges of values to allow for fluctuations.

Capital requirements and operating costs can be estimated more accurately after the computer evaluation. Profitability of the venture can be expressed in numerous terms. It would pay to have computed such values as cash value, operating profit, net return on investment, etc.

Computer centers offer complete services to small mines that cannot economically justify purchase of equipment

Many small companies cannot justify a large computer, but there are calculating punches and small computers that could be used both in the accounting department and for scientific calculations. Many mine accounting offices have a calculating punch that is used solely for accounting work, whereas it is capable of performing some scientific calculations.

An engineer for a small company has the responsibility to determine what routine and complex calculations could economically be made with a computer at a computer center. It would be advantageous for a mining consultant familiar with computers to make a short survey of the areas of possible economic application and make recommendations and cost estimates of computer use. Further studies could be made as desired. The obvious advantage in having a mining consultant familiar with computers hired for a feasibility study would be that he is basically familiar with the calculations and the overall operation and should be able to spot the pitfalls of computer applications to certain types of calculations or data. Good communication is also another advantage of having a mining consultant make a feasibility study. An engineer of a small property will have no communications problems with a mining consultant, and the mining consultant with computer experience can then, in turn, adequately communicate with the computer center personnel or consultant.

Centers often have ready programs

Utilization of data-processing equipment at a computer center requires a basic knowledge of: (1) computer programming methods; (2) computer languages available; (3) computer programs available; (4) required data form for program(s); and (5) computer center policies and facilities.

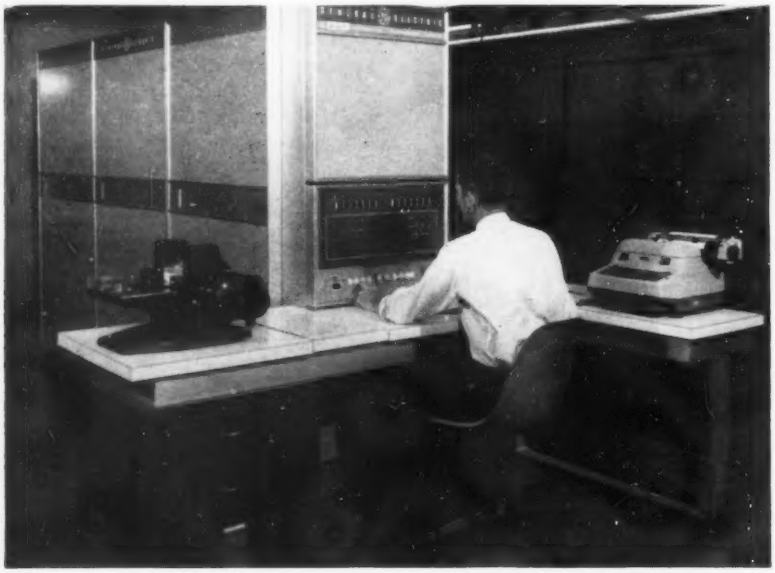
Closed-shop computer centers are set up so that the company engineer cannot operate the computer. The company engineer brings the computer program and/or data to the computer center and obtains the results after the computer center personnel make the production run.

Open-shop computer centers allow the engineer to operate the computer if he so desires. This arrangement is more satisfactory when confidential data are being processed. The company engineer or consultant can process the data and obtain the output directly. Then the computer storage can be zeroed for maximum security.

All computer centers have a list of available programs for the specific computer of interest. Computer manufacturers have complete "canned" routine lists that are also available to prospective customers.

Feasibility studies are made to determine if it is economical to use a computer to solve a problem. Basic to the study are the following essentials to computer utilization: (1) a problem; (2) a method(s) to solve the problem with desk calculators; (3) a general flow chart of the method(s) to solve the problem; (4) analysis of the method(s) used to solve the problem, with the aim of deciding on one method and preparing a detailed flow chart; and (5) development and testing of a computer program to solve the problem.

An engineer or geologist making feasibility studies must integrate the computations in order to reduce



GE-225 is a medium-priced, general purpose computer made by the General Electric Company that can be used for scientific applications as well as complex business data processing. This all-transistorized system automatically translates English words and symbols into machine language thus expediting programming techniques.

computer data-processing costs and make more computer solutions possible, therefore reducing total data-processing time. Table No. I compares costs of calculating the averages of drill-hole assays and ore reserves for 10,000 assays.

Table I shows that by making different types of calculations with the same punched-card data, computer processing of data is economical. Other calculations can be made in such broad areas as mine planning and layout, development, production scheduling, process control, and general mine engineering calculations.

Costs of developing computer programs range from $1 to $10 per instruction. An average of $5 is common for medium sized computers. The cost of developing the Pima pit expansion program for the Pima Mining Company, Tucson, Arizona, was more than $750, while most of the shorter programs would have cost an average of about $50 each. It is estimated that development of the available ore reserve computer programs would cost over $5,000. Thorough analysis of the problem by company engineers and geologists can reduce the costs of computer development greatly.

Data assembly costs are variable. Hand assembly of drill-hole data into triangles cost $0.10 per triangle or $25 for 250 triangles. Costs of other types of data assembly will depend on the amount of merging and sorting required and to what extent business machines are used.

Exact computer costs can be obtained from computer centers or equipment representatives. END

TABLE NO. I

Comparison of Costs of Calculating Drill-Hole Assay Averages and Ore Reserves for 10,000 Assays With Desk Calculators and a Digital Computer

Calculation or Operation	*Costs*		*Processing and Computational Time*	
	Desk Calculator	*Digital Computer*	*Desk Calculator*	*Digital Computer*
Key—punch data	—	$175	—	2 days
Calculate drill-hole assay averages	$ 40	$ 20	1,000 minutes	9.6 minutes
Calculate ore reserves for a given bench height by the polygonal, triangular, and statistical methods	$3,500 +	$250	6-man months +	2 hours
Total	$3,540 +	$445	6-man months	3 days

What's All This Fuss About Computers?

continued from page 27

analog computer does not require complex programming, and changes in the system can readily be made by altering connections. The output can be read directly off a curve plotter which can plot perhaps half a dozen or more variables simultaneously, thus allowing a quite extensive analysis of the operation of a system. In general, solution can be obtained more quickly than with digital computers, but the range of problems that can be solved is more limited.

Analog computers have not, however, been used as extensively as digital computers, particularly for large-scale problems. One reason is that analog computers are seldom accurate to more than one percent, and five percent accuracy would be considered good for very large problems. Digital computers can give accuracies to one part in 1,000,000 (or more). Secondly, the cost of the computer goes up sharply with the complexity of the problem because the additional amplifiers are required. A third reason is the difficulty or cost of introducing 'statistical' parameters into the problem.

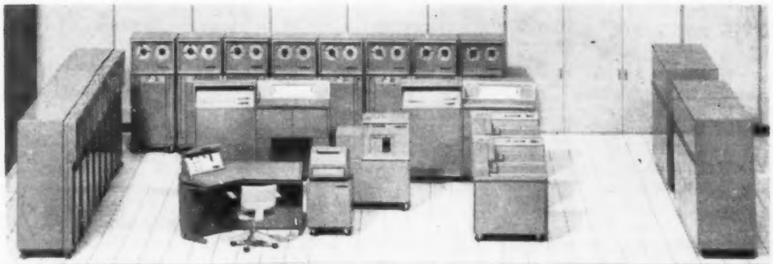
Small analog computers are being used more and more in plant and process control systems, and have the advantage of being able to create information which can be used in analysis by digital computers (using an analog-digital converter). One such installation has been reported in a cement plant others are being used in the petroleum and chemical industries.

A computer, be it digital or analog, is not a universal panacea or an ever-ready problem solver. It offers advantages in both data processing and 'scientific' computations which will become even more important in the coming years. In the long run, the "scientific" uses of computers may well prove a greater boon to management and industry as a whole than the more common use of computers to perform clerical tasks. When the knowledge, ingenuity, and creativity of such experts as analysts, mathematicians and programmers are coupled with the use of the computer as a logic machine, we not only use computers to the full but obtain for ourselves a greater insight into the workings of complex organisms—one of the most fascinating of which is the modern industrial enterprise. END

Computers For Equipment Analysis

Today's mining operations require top performance from equipment systems

by **E. R. Drevdahl**
Associate Professor of Mining Engineering
University of Arizona
Tucson, Arizona



BURROUGHS B5000 computer is a versatile processing system designed to reduce the amount of time required to program scientific problems. It has up to 26 input/output devices, eight magnetic core memory units, and can do up to 250,000 additions per second. Cost $1,000,000; monthly rental $15,000.

In modern mining operations it is becoming increasingly important that more consideration be given to the planning and engineering of equipment systems. The variety of equipment available today makes it extremely difficult to determine what combination of machines will give the best results without making a number of theoretical equipment system comparisons to determine the combination of equipment most likely to give the best results under the mining conditions contemplated.

It is quite possible by utilizing basic engineering fundamentals, equipment specifications, and average performance data, to estimate the output and cost of various machines or machine systems with respect to a common basis. With this information many comparisons can be made of various systems to determine the most likely combination to produce optimum results on a specific project.

In the analysis of equipment systems we simulate the capabilities of equipment with mathematical expressions. These expressions do not necessarily express actual output but simulate the reaction of actual systems.

Output and costs determined first

It is possible, using modern mathematical techniques, to express entire mining systems in terms of a mathematical expression. With the aid of high speed computers this system and all its variables can be manipulated to determine what combination of conditions will give optimum conditions.

The general procedure in the analyses of equipment is first to determine the output of the equipment or equipment system considering conditions the equipment will be used under, such as grade, altitude, haul distance, etc. If alternatives are to be investigated they will be examined in the same manner. The cost of owning and operating the equipment under the conditions investigated can then be computed and the unit cost found by dividing the ownership and operating cost by the output. If the unit cost versus output or haul distance is known for a wide range of possible working conditions, these can be plotted and the break-even points (points of equal unit cost) can be determined for various systems. The combination of machines and conditions most likely to give the lowest unit cost or highest production or any other situation desired can be selected. It is possible to study the effect of new equipment, the performance of various brands of present equipment, the optimum time to replace equipment, and many other factors of value in the planning and operating of mines.

It is possible to predict with reasonable accuracy the ability of various types of equipment to handle different job situations. This is being done on many large construction projects. Some projects have calculated at what speed to travel and when to shift for all segments of the haulage route. When these calculations are made for the average truck it gives a good check on performance.

Multiple uses for computer at mine

The first application of computers in most operations will most likely be in the field of data processing and will be similar to the use now in operation by most accounting departments.

The next use will be for engineering analysis and the development of systems design tables. This is now being done by many equipment manufacturers. The next step will be into the field of systems engineering with the possible application of linear programming to the scheduling and optimizing of various mix-type problems. This procedure will be applicable to problems of supplying a required blend of minerals or grade of ore to the mill, maximum utilization or conservation of a mineral deposit, minimizing costs, and maximizing equipment utilization.

When we have problems involving an equipment waiting line, such as trucks waiting to be loaded by a shovel, we may apply queuing theory to the solution of the problem.

Modern computers will increase the scope of investigations that can be made in all phases of mining engineering; however, the computer is just a tool and the results of any computer work will only be as good as the effort expended in its utilization and the ability of the personnel doing the work. The computer is not a substitute for the abilities of mining engineers; on the contrary it will require more scientific effort on the part of the mine staff if efficient utilization of this new tool is to be achieved. END

COMPUTER CENTERS welcome your problems

Many companies do not have enough work to keep a computer busy fulltime, and thus cannot justify the expense of ownership. To fill the need of these companies a new type business has begun to flourish in the United States and abroad. These are the Computer Centers where you can take your technical and operational problems—whether simple or complex—and they will handle them on a fee basis, efficiently and quickly.

The centers have trained men and equipment who (1) analyze your problem, (2) determine the need for computer processing, (3) develop the program for the computer, (4) process by computer if that is the best method, (5) give you the best solution or solutions to your problem, and (6) present you with the bill for their services.

The following is a selected, partial list of some of the more than 200 computer-consultant centers in the United States and abroad. The centers listed below have had experience with the minerals industries, and are prepared to undertake your exploration, mining, metallurgical, or smelting problems. A more detailed list of computer centers can be obtained by writing to: Association of Data Processing Service Organizations, 1000 Highland Avenue, Abington, Pennsylvania.

General Electric Company
3550 North Central Avenue
Phoenix, Arizona

Numerical Analysis Laboratory
University of Arizona
Tucson, Arizona

Western Computing Consultants
826 E. Lister
Tucson, Arizona

Computer Division
Bendix Corporation
5630 Arbor Vitae
Los Angeles 45, California

Marc Shiowitz & Associates
13015 So. Gramercy Place
Gardenia, California

EAI Computation Center
1500 East Imperial Highway
El Segundo, California

RCA Systems Center
343 Sansome Street
San Francisco, California

Remington Rand UNIVAC
42 First Street
San Francisco 5, California

Western Computing Center
Philco Corporation
3875 Fabian Way
Palo Alto, California

Colorado School of Mines
Research Foundation
Golden, Colorado

Computation Laboratory
Harvard University
Cambridge, Massachusetts

Digital Computation Laboratory
Massachusetts Institute
of Technology
Cambridge, Massachusetts

Numerical Analysis Center
University of Minnesota
Minneapolis 14, Minnesota

Applied Data Research, Inc.
759 State Road
Princeton, New Jersey

Computer Usage Company, Inc.
18 East 41st Street
New York 17, New York

Service Bureau Corporation
425 Park Avenue
New York 22, New York

Department of Geology
Oregon State College
Corvallis, Oregon

London Computer Centre
Ferranti Ltd.
68/71 Newman Street
London W. 1, England

Computer Consultants Limited
Cecil Court,
Enfield. Middlesex, England

Leo Computing Services Ltd.
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South Africa

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MINES AND SMELTER AT
SUPERIOR, ARIZONA

Mining Exploration

continued from page 31

This means to the mineral operator that rapid exploration or areas of interest can be performed with mineral locations spotted and analyzed in terms of the size, shape, position and grade of the deposit. This information can be incorporated either into the long or short programs of the operator.

An established geophysical theory can be introduced or programed into the computer. This requires a geophysical engineer and a computer specialist. In essence the geophysical engineer communicates his training to the machine; that is, he gives the machine the ability to perform the same tasks he has been trained to perform. Thereafter the machine can tirelessly, at fantastic rates, and without error perform these tasks, and so what was initially, for practical purposes, impossible due to the enormity of computation is now within immediate reach. Within hours after field data is transmitted to the machine, maps and calculations illustrating the mineral deposit are available as direct output product.

An example of the extension of geophysical interpretational capabilities through the use of computers is in the application of gravity and magnetic techniques. The field data are fed into the machine which then performs the necessary adjustments of the values and plots these on maps. Approximate rules are then applied to these maps which will give the general position, size and shape of the mineral deposit. The machine is then directed to construct a 'theoretical ore body' utilizing these approximations and compute its so called 'response.' This response is then compared with the actual field data and adjustments are incorporated into the theoretical ore body as required until the response patterns of both the theoretical ore body and the actual field data are near identical. The machine then prints out a 'picture' of the theoretical ore body.

It is necessary to try combinations of physical properties in this procedure until those properties are obtained which give the best fit. Often simultaneous gravity-magnetic analysis can be used to indicate tenor. Computers are uniquely capable of performing such ore body analyses in the case of complex ore bodies where 'zones' of mineralization occur which vary in grade. The computer assigns to each zone a unique grade and then proceeds to sum up the contributions of each zone to the total response, cycling until the distribution is assigned which gives the most perfect fit. Grade determinations are thereby achieved. Electromagnetic techniques integrated by a computer into simultaneous magnetic and gravity analyses gives even a greater flexibility and range to the possibilities of mineral deposit interpretation.

For regional exploration programs, simultaneous geophysical surveys can be performed, which are then examined by a computer and the most favorable areas selected by cross correlation of data. Intensive analysis of the nature outlined above can then be performed on selected areas. END

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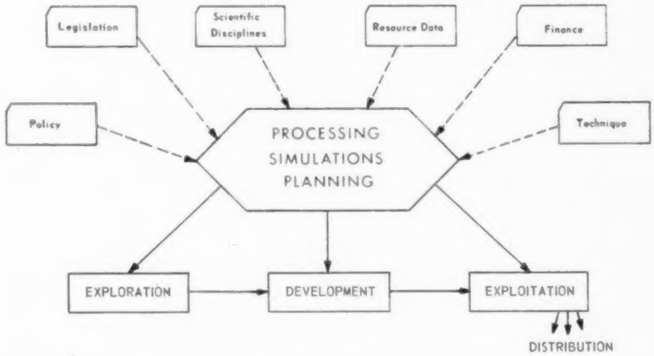
MINING OPERATIONS RESEARCH



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An old-timer in California—Photo by Mark Shaw

Mining tells a story

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Once upon a time man made do with wood, stone and bone alone.

Then, as legend has it, copper came by accident from the ore-rich rocks of a long-burning campfire.

Inspired by his discovery, man reached out from the age of stone to the age of metals—seeking step by step the utilitarian, the precious, the decorative.

Thus progress has followed the prospector, and the prosperity of nations has come to depend in good part upon mining and metallurgy.

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There are bank loans for getting the ore out of the ground, and loans for processing it. There are loans for transporting raw metals, for converting them into manufactured products. And finally there are loans to bring these products to market where all can see and buy.

That's banking's chapter in the story of mining. And The Chase Manhattan Bank, first in loans to business and industry, is proud to present this tribute to mining, a competitive enterprise providing a variety of products which help Americans exercise their basic right to pick and choose.

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PRODUCTION EQUIPMENT preview

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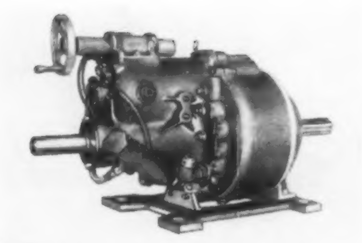


Variable Speed Transmission

A 10 horsepower variable speed hydraulic transmission that provides infinitely variable speeds from 0 to 1,600 rpm has been introduced by Roberts Electric Company of Chicago.

Suitable for such heavy-duty applications as: conveyors, winches, lifts and hoists, blowers, compressors, pumps, crushers, shakers, separators, etc., it is driven at 1,800 rpm or less with any 2 or 10 horsepower motor. Precise speed selection is obtained by rotation of hand wheel giving infinite number of speeds through entire range of unit. Weight is 100 pounds. Write: **Dept. MW, 849 W. Grand Avenue, Chicago 22, Illinois.**

Automatic Emergency Lighting

A new low-cost automatic emergency lighting unit to provide protection against hazards of power failure has been developed by The Electric Storage Battery Company.

Fully automatic, the new Exide Lightguard Model D operates instantaneously if normal power fails and shuts itself off when power is restored. Powered by a nine-volt dry-cell battery, the unit costs less than comparable wet-cell emergency lighting equipment and requires less maintenance. It can be installed and left unattended for the entire service life of the battery. A fresh battery can be installed in a few minutes and retains 85 percent of its initial capacity after standby service for one year. Write: **Dept. MW, Rising Sun and Adams Avenues, Philadelphia 20, Pennsylvania.**

Special-body Truck Leasing

A new, low-cost plan, under which special-body trucks used in the mining industry can be leased without maintenance for from four to eight years, was announced today by Wheels, Incorporated, Chicago, Illinois. The long-term lease plan is an innovation for special-body, over-the-road equipment used by mining firms since the equipment can now be leased without full maintenance, repair, and garage service. Write: **Dept. MW, 6200 North Western Avenue.**

Work Sheet for Blasting Costs

An easy-to-use work sheet that permits accurate compilation of blasting costs is announced by Austin Powder Company.

Called the Austin Blast Report, it provides an outline for figuring in number of holes, depth of water, burden, spacing, hole depth, kind of rock, type and cost of explosive, etc. It also provides a reduction formula to convert overall figures into cost per yard or cost per ton of material. For copies write for form **ABR, Dept. MW, Austin Powder Company, Cleveland 13, Ohio.**

Vermiculite Filters Fumes

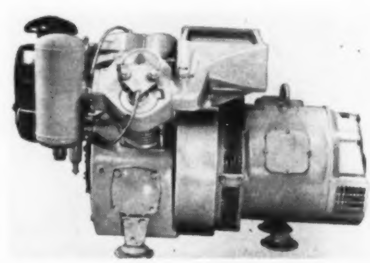
A new method of filtering poisonous nitrous fumes in mines permits heavier blasting schedules and provides added safety for miners, according to information from Zonolite Company.

In the process, nitrous fumes given off in blasting operations are filtered through a bed of expanded vermiculite impregnated with special chemicals. Vermiculite is lightweight, fireproof, porous absorbent mineral, capable of holding chemicals in large quantities, and the fume-laden air will pass readily through the properly sized material. For details write: **Dept. MW, 135 South Lasalle Street, Chicago 3, Illinois.**

Portable 110 Volt AC Power

A major breakthrough in electronics now makes it possible to provide 110 volt alternating current from a 12 volt storage battery.

The Activerter, a development of The Electric Storage Battery Company, provides 110 volt AC power any place a 12 volt battery is available or can be taken. It can be used to operate electric power hand tools, regular electric light bulbs, electric blankets, radios, TV sets, hand vacuum cleaners, and many other electrical devices that do not exceed the wattage output of the Activerter. ESB Activerters are available from 150 to 500 watts output. Write: **Dept. G, P. O. Box 6266, Cleveland 1, Ohio.**



Powerful Small Air Compressor

Market introduction of a new 30 horsepower air compressor delivering 141 cubic feet of air per minute is reported by Atlas Copco. Foot mounted on bonded rubber, this new TT6 compressor eliminates foundation costs, and offers all the advantages of a heavy-duty machine while retaining the flexibility of a portable compressor. It is a two-stage, single acting unit featuring total air cooling, and has an outstanding capacity to weight ratio, obtained by the use of light weight metal alloys for many parts. Write: **Dept. MW, 545 Fifth Avenue, New York 17, New York.**

Clutch and Brake Idea Book

One of the most comprehensive catalogs on air-tube disc clutches has just been printed by Wichita Clutch Company, Wichita Falls, Texas. The colorful 32-page catalog contains complete data covering all types of applications. Also included are suggested clutch and brake arrangements to help in design or unusual applications. For a free copy write direct to the company.

Filter 99.99 Percent Efficient

Gelman Instrument Company announces the development of a new high efficiency air filter demonstrated to be 99.998 percent efficient using test aerosols of 0.3 micron in diameter. The filter is made of micro fibers of polystyrene, and is capable of retaining extremely high dust loadings without significant changes in resistance of the filter. Write: **Dept. MW, 106 N. Main Street, Chelsea, Michigan.**

Aerial Photographic Services

Examining, measuring, and evaluating the earth by means of aerial photographic interpretation, geophysics, aerotechnics, and other advanced scientific and engineering techniques; and the value of these practices, are described in a new 32-page brochure concerning the services of Geotechnics and Resources, Inc. Write: **Dept. MW, Westchester County Airport, White Plains, New York.**

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WHAT'S GOING ON in mining

PERU . . .
Southern Peru Copper Mines 165,000 Tons Ore and Waste Daily

Southern Peru Copper Company has purchased 30 new 37-ton Diesel dump trucks for waste stripping hauls at its Toquepalla mine. The new and larger trucks are necessary to maintain the ore plus waste mining rate of 165,000 tons per day in the face of longer waste hauls to dumps as the mine grows larger. To the end of 1960, a total of 183,000,000 tons of ore and waste have been removed of which 12,000,000 were ore. In 1960 9,400,000 tons of ore were mined and milled and 42,600,000 tons of waste stripped to maintain the 4.5-to-1.0 stripping ratio. The ore averaged 1.75 percent copper, higher than the average grade of the ore body, but with an ore exposure of only three kilometers on the ore benches it proved impossible to blend ore for grade by varying shovel loading rates. It is figured that at least eight to 10 kilometers of ore faces must be exposed before proper blending can be achieved.

Despite the day-to-day change in ore grade, the flotation mill operated very efficiently to recover 445,000 tons of 32.0 percent copper concentrate. The chalcocite content of the near surface ore which becomes predominantly chalcopyrite in depth accounts for the high-grade copper concentrate as well as the high-grade mill feed. The mill was shut down only three times during the year—once when a flash flood filled the tailing canal and twice by a failure in the transfer joint between mill and tailing thickener.

Two major earthquakes—Arequipa in January and Chile in May—failed to damage any of the buildings or equipment. However, the Chilean earthquake caused the sea to drop below the cooling water pump inlet for the power plant at Ilo. Accelerated growth of mussels in the cooling water intake restricted flow until they were killed with hot water.

After early reverberatory side wall leaks were repaired, no further difficulties were encountered in smelting and 145,000 tons of blister copper were produced in 1960.

Continuous maintenance of the railroad right-of-way between the smelter at Ilo and the mine was necessary because of settling of some of the large fills. Smelter slag is used for ballast.

Southern Peru is managed by American Smelting and Refining Company which holds a 51.5 percent interest, with Cerro Corporation holding 22.25 percent and Newmont Mining Corporation and Phelps Dodge Corporation owning in equal shares the remainder of the stock.

SOUTH WEST AFRICA . . .
Tsumeb Builds Two New Smelters, a Refinery, and Mill

Metallurgical plants costing $20,000,000 are now under construction by Tsumeb Corporation Limited to make it one of the world's most important integrated base metal producers. Until the new lead smelter and refinery are completed and in operation in 1963, and the new copper smelter in 1962 all concentrates will continue to be exported to Europe and the United States for smelting and refining. There are no announced plans for smelting or refining the zinc concentrates at the mine site.

The third new metallurgical plant is a 750 ton per day differential flotation mill being built at the Asis mine which is now being developed for production by 1962. The Asis mine, 65 railroad miles from Tsumeb, has developed reserves totalling 2,000,000 tons of 3.6 percent copper, 4.4 lead, and 0.5 zinc. Exploration is continuing with favorable prospects for developing additional tonnages.

The most recent new metallurgical plant to be placed in operation at the mine is the 10,000-pound-annual, semi-refined, high-grade, germanium dioxide plant which recovers byproduct germanium. The concentrate is shipped to the United States for refining.

Despite the mining and milling of 614,205 tons of ore in the last fiscal year, Tsumeb increased ore reserves above the 30th level (3,150 feet deep) by 383,000 tons. Ore milled averaged 5.02 percent copper, 13.67 lead, and 5.30 zinc in comparison to mine reserves of 7,934,620 tons averaging 5.18 percent copper, 14.85 lead, and 4.47 percent zinc.

The 30th level is by no means the bottom of the ore as a diamond drill hole hit ore at a depth of 4,150 feet below surface, but further drilling will be needed to delimit the deposit at that level. In preparation for mining below the 30th level a new underground shaft is being sunk from the 30th to a projected 38th level. Reserves to a depth of 500 feet below the 30th level are 3,000,000 tons, averaging 4.7 percent copper, 10.3 lead, and 2.3 zinc.

Tsumeb is managed by Newmont Mining Corporation which owns 29.125 percent of the stock. Other owners include American Metal Climax, Inc.

MEXICO-CANADA . . .
American-Climax Sells Penoles Control, Joins Canadian Tungsten

A 51 percent interest in American Metal Climax, Inc.'s Mexican mining, milling, smelting, and refining operations has been sold to a group of private Mexican investors for $8,169,000. American Climax retains the remaining 49 percent and the two have formed a new company, Metalurgica Mexicana Penoles, S. A., to continue operation of all the properties.

This is American Climax's action in regard to the recent Mexicanization of mining properties and the new firm will have important tax advantages because it will be 51 percent Mexican owned.

In addition to continuing operation at the Penoles lead-silver-zinc mine and related concentration and smelting plants, the new company plans expansion to include the building of a new 30,000-annual-ton zinc smelter at Torreon, a new sulphuric acid plant, and a sodium sulphate plant at Laguna del Rey where the new company has important mineral claims. Torreon is the site of a lead smelter that smelts Penoles concentrates. The zinc concentrate having been shipped to Blackwell, Oklahoma where American Climax operates a zinc smelter.

American Climax's Mexican interests in addition to Penoles include a 37.69 percent of interest in San Francisco Mines of Mexico, Limited, and 29.41 percent of Mazapil Copper Company Limited.

Far to the north in Canada's Northwest Territories, American Climax's Canadian subsidiary—Northwest Amax Ltd.—is joining with two Canadian mining companies, Ventures Ltd. and Dome Mines Ltd., in the financing necessary to bring the Watson Lake ore body of Canadian Tungsten Mining Corporation Ltd. into production. This high-grade tungsten ore body can be mined initially by open pitting, but it will require construction of a new road to the Alaska Highway to afford fast and cheap transportation to the deposit. Air transport has largely been used to date. Exploration of the main ore body to date has proven 1,176,400 tons of 2.47 percent WO_3. This tonnage and grade make it one of the world's two most important tungsten deposits. The other is Korea Tungsten Mining Company's Sang Dong ore body in the Republic of Korea. Metallurgical testing of the Watson Lake ore has shown that a satisfactory grade of concentrate with a good recovery can be made from the ore.

Arizona

Magma Copper Options 132 Claims Near Superior

Mining claims of the Belmont Copper Mining Company, two miles southeast of Superior, Arizona, are being purchased by the Magma Copper Company. Sale price for the Belmont holdings is set at $800,000, with an option to reconvey the property or make payment by January 1, 1976.

The Belmont property consists of 120 unpatented and 12 patented claims which are contiguous with holding of the Queen Creek Copper Company. In 1958, Magma took a 12-year option to purchase Queen Creek's 50 mining claims for $375,000. The combined Belmont and Queen Creek properties cover 3.5 square miles.

In January of 1956, Anaconda Company optioned the claims held by Belmont Copper Mining Company, Queen Creek Copper Company, Magma Superior Copper company, and Grand Pacific. However, the options were dropped in October of that year, following a limited amount of drilling described as "disappointing."

For many years the Belmont mine was one of the main sources of water supply for the town of Superior. Approximately 194,000 gallons of water per day were pumped from the 1,650-foot main shaft, but the lease with the Arizona Water Company expired early this year. Superior's main water supply now comes from wells near Florence Junction.

The Belmont Copper Mining Company was organized in 1925 by the Alexander Mackay interests of Scotland. The three-compartment shaft was sunk to the 1,650-foot level and more than 17,000 feet of underground development work completed, plus 50,000 feet of diamond drilling. Depression conditions, together with the death of company officers, forced the termination of Belmont's development plans. Since then, activity at the property has been intermittent and largely by lessees.

Union Carbide Stakes, Drills Zeolitized Volcanic Ash Bed

A group of more than 200 placer mining claims covering over 4,000 acres, has been located in southeastern Arizona by Union Carbide Nuclear Company of Grand Junction, Colorado. The property lies 12 to 15 miles northeast of Bowie, in the San Simon district of Graham and Cochise counties, on the west side of San Simon Creek.

Union Carbide Nuclear's interest in the area is said to lie in the six-inch thick bed of zeolitized volcanic ash. No information is available concerning the potential industrial uses for the material.

Currently, Union Carbide Nuclear Company is bulldozing access roads for the location of rotary drill holes. Plans call for at least 200 holes—one for each claim to show discovery. The maximum depth is expected to be 70 feet, minimum depth 10 feet, for an average of about 35 feet. The drill contract is held by Mitchell Co., Inc., of Grand Junction, which is rotary drilling with one rig.

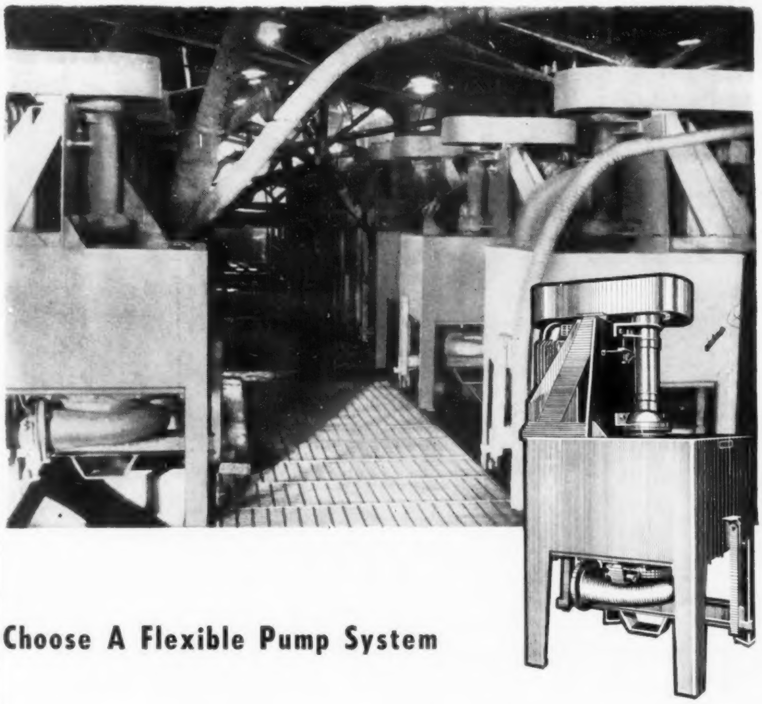
The nonmetallic deposit being explored is said to be covered by 0 to 60 feet of overburden. Below the overburden there is a top layer of three to four feet of soft, powdery, dark green material which has been classified as "partially altered volcanic ash." Below this lies the bed of lightweight, porous, yellowish-orange material, about six inches thick, which breaks off in slabs like flagstone, and can be crushed easily to a fine powder. This material has been classified as "zeolitized volcanic ash." Below is a thick deposit of dark green, fine-grained plastic clay with a fairly high alumina content.

Early newspaper reports of the activity in the Bowie district referred to the clay deposit as "bauxite."

The original locations in the area were made by Frank W. Clark, Bowie, and associates. They hold 52 unpatented claims, both placer and lode, the principal group being known as "Tufa-tex." Clark has quarried and sold a small tonnage of his "Tufa-tex" for experimental purposes in an effort to develop a market for the beautifully textured rock.

Bagdad Copper Corporation recently inaugurated its $2,500,000 acid-leach-precipitation plant which, at peak output, is expected to produce 40,000 pounds of copper daily. Dilute sulphuric acid from the plant, largest of its kind in the state, is irrigated over two large copper oxide dumps. The resultant pregnant solution is pumped from the collecting ponds to vats containing de-tinned shredded cans where cement copper is precipitated. Acid is then added to the neutralized solution which is recirculated through plastic and stainless steel lined pipe to the irrigating ponds atop the oxide dumps, repeating the cycle.

Kennecott Copper Corporation has completed the 800-foot developent shaft at its Safford, Arizona property. Crosscutting and drifting will be started soon



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Where it is desired to change the flowsheets and the amount of pulp, without affecting the work of the pumps, SALA's Vertical Pumps will do the work. They are designed for pumping abrasive material, such as pulp, sand, etc. The open bowl of the pump makes it very suitable for pumping flotation froth, since it gives the air a chance to escape when the froth bubbles are broken up.

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2. The open bowl without stuffing boxes;
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4. Abrasive as well as corrosive material can be pumped.

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from the bottom of the shaft under a contract with **Boyles Bros. Drilling Company**, which sunk the shaft. This lateral development will open the deposit for bulk sampling and metallurgical pilot plant testing of samples. The mineralized rock mined in this development will be crushed and passed through a small sampling plant built adjacent to the shaft. Surface development drilling at Safford was completed last year. Annan Cook is resident geologist.

Bear Creek Mining Company has taken over, under option to purchase, the **Old Reliable** and adjoining properties in Pinal County, Arizona, and has also staked about 60 mining claims on the western slopes of the Galiuro Mountains across from San Manuel mine in the same area. The option was acquired from the **Siskon Corporation** of Reno, Nevada. Geological mapping and some exploration work are in progress, with **R. S. McClintock Diamond Drilling Company** using two diamond drills in testing the property. The claims are located in the Copper Creek-Sombrero Butte area, scene of much mining activity before and during World War II.

Phelps Dodge Corporation is currently conducting geological and geophysical studies of mineral deposits in the Miami area for their commercial possibilities. Further activities will be mainly determined by the results of the studies under way, according to Walter Lawson of Douglas, general manager of PD's western operations. Current studies are a phase of an exploration program in the area, directed by Elmer E. Maillot of Douglas, director of western division explorations. Phelps Dodge has an option on many claims in the Miami area and located additional unpatented claims for exploration purposes. The program has been under way for about six weeks.

The Ray Mines Division, **Kennecott Copper Corporation,** Hayden, Arizona, has returned to a seven-day work week. As a result the company has recalled the 192 workers who were laid off when the production schedule was reduced to six days a week last February.

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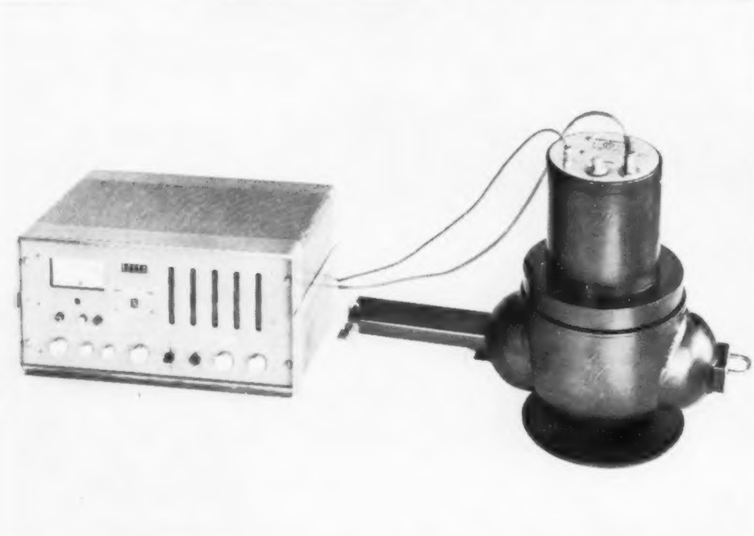

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The Laboratory Berylometer model BEL 100B, pictured above, includes; Scaler, Detector Head and Lead Castle. Write for complete specifications and prices.

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California

Natomas Company is now operating only one gold dredge at Folsom, California, because of inflation in the face of the fixed gold price. Four dredges are idle, but are being kept in good operating condition in the hope that higher grade ground can be found in the United States or abroad, which can be dredged at a profit. An additional dredge is now being reconditioned at the Natoma shop for shipment to a gold placer high in Peru's southern Andes. In 1960 4,367,414 yards were dredged at Folsom from which 10.24 cents per cubic yard was recovered. Operating costs were 7.46 cents per yard and depreciation and depletion 1.42 cents.

The **Association of American Miners, Inc.,** has been formed at Marysvale, California, to "bring together all those interested in mining and the mining industry in these United States of America." Alfred A. Randolph, president, 316 Second Street, Marysvale, California, welcomes members and will be glad to answer any questions about the new organization.

The Boron, California, open pit boron mine and refinery of the **United States Borax & Chemical Corporation** resumed a seven-day-per-week operating schedule in April to make shipments to fill the steady increase in orders. The plant had been cut to a five-day week in January and raised to a six in March. The corporation is just starting an expansion program to increase the production capacity of anhydrous products by adding fusing facilities. W. J. Diffley is Boron manager.

Central

The **New Jersey Zinc Company** has suspended production at its **Flat Gap,** Tennessee mine, idled a second battery of vertical retort furnaces at its **Palmerton,** Pennsylvania smelter, and cut operations 25 percent at its **DePue,** Illinois zinc smelter. These cut backs are a step toward bringing zinc production and consumption in balance. The Flat Gap closing will give the company time and the opportunity to mine about 10,000 tons of unmineralized clay that slid into the mine workings along a large oxidized fault. Excessive spring rain fall apparently softened the clay enough to permit it to slip into the mine.

Gill Montgomery, vice president and general manager of the **Minerva Company** is leading a campaign to secure equal federal and state financing for an aero magnetic survey of the Illinois fluor-

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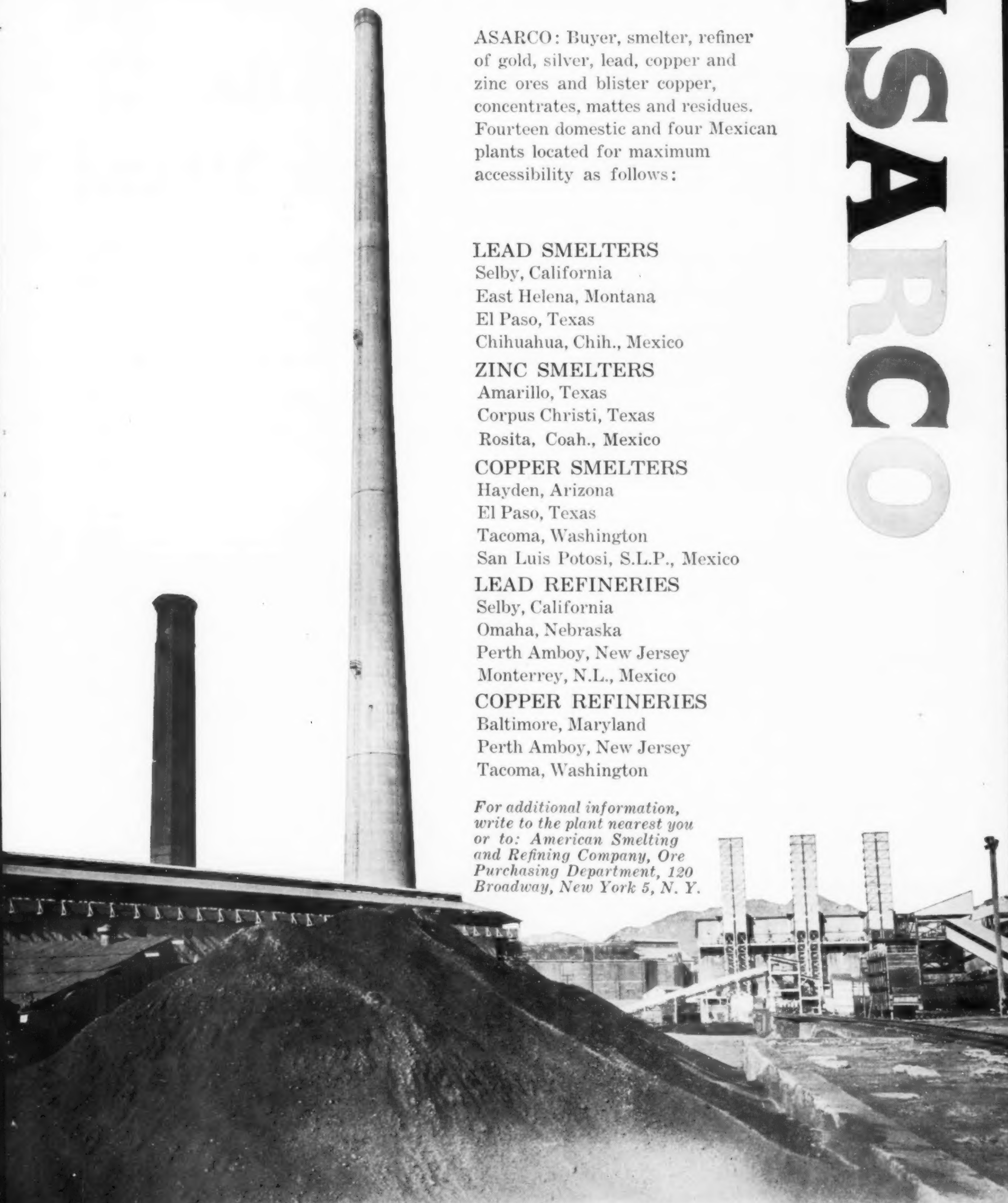
For additional information, write to the plant nearest you or to: American Smelting and Refining Company, Ore Purchasing Department, 120 Broadway, New York 5, N. Y.



International Nickel Selected Marcy Mills for its new Levack Plant

Inco's new 6000 ton per day Levack Mill, in the Sudbury district of Canada, features extensive use of automatic and remote controls designed for maximum efficiency to offset rising costs. The company states that: "The experience gained from its Copper Cliff and Creighton mills, operating since 1930 and 1951 respectively, proved of great value in designing the Levack Mill." Marcy Mills are used at both Copper Cliff and Creighton.

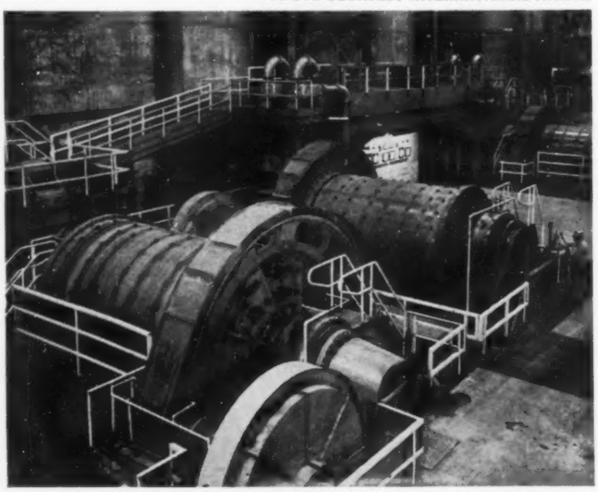
INCO HAS PURCHASED A TOTAL OF 61 MARCY MILLS

International Nickel Company of Canada, Ltd., world's largest producer of nickel, has purchased a total of 61 Marcy Mills including the four at Levack.

TYPICAL EXAMPLE OF MINE AND SMELTER'S WORLDWIDE SERVICE

Canadian Vickers, Ltd., Montreal, Mine and Smelter's sales agent and licensed manufacturer for Marcy Mills in Canada, in cooperation with International Nickel and Mine and Smelter, manufactured and serviced the Marcy Mills for Levack.

PHOTO COURTESY INTERNATIONAL NICKEL



LEVACK MILL. Photo shows one of the two grinding sections. Each section includes one 10′ x 15′ Marcy Rod Mill and one 10′ x 14′ Marcy Ball Mill. Central instrument panel controls entire grinding operation.

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spar district. Geologists in the district believe that such a survey might locate faults in the pre-Cambrian basement rocks under the fluorspar district. Correlation with the known ore bodies and the faults might then lead to discovery of other ore bodies as the faults are believed to have been mineralization channel ways. Supporting the proposal are the **Aluminum Company of America, Ozark-Mahoning Company, Rosiclare Lead and Fluorspar Mining Company,** and the **Minerva Company.**

The **American Smelting and Refining Company** has made tentative plans to sell a large part of its 7,800 acres of mineral lands in Newton County, Missouri. ASARCO has done no mining in the area since 1945 although much of the surface has been farmed by leasees. The area extends from the cities of Spurgeon to Jolly east of Granby and from Diamond to Aroma south of Granby.

Copper Range Company made a small profit from its **White Pine,** Michigan mine operation during April. The first quarter loss was $395,605 compared with $1,070,449 in the same 1960 period when the mine was closed part of the time by a strike, reports president James Boyd. Mine production is being gradually built up to mill capacity and reached 16,000 daily tons in May. Cleaner and more efficient mining have increased mill heads to 23 pounds of copper per ton with the chance of reaching 24 in the near future. Copper recovery in the flotation mill was raised from 82.37 percent in 1959 to 84.54 percent in 1960 by use of new reagents, and improving grinding.

U. S. Gypsum Company has started development of its new underground gypsum mine, located 18 miles from Saltville, Virginia. When the mine is developed, it will be mechanized with Sanford-Day Transloaders.

Tennessee Copper Company has dropped its option on the **Silver Hill** prospect, located near Lexington, North Carolina. Prospecting at the property included surface and underground diamond drilling, deepening an incline shaft, and extensions of drifts and cross cuts. The prospect occurs in the Carolina "slate" belt which is a group of metamorphosed volcanic rocks.

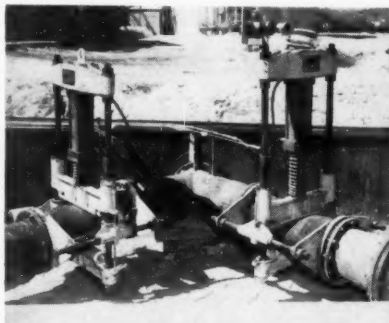
Colorado

Idarado Mining Company increased productivity at its **Idarado-Black Bear-Smuggler Union** mines in Ouray and San Miguel counties, Colorado during 1960 to 8.84 tons milled per underground shift (7.97 in 1959). Tons milled per total operating shift increased to 5.72 from 5.07. The company's lead-copper-zinc differential flotation mill at Pandora treated 432,750 tons assaying 0.054 ounces gold, 1.71 ounces silver, 2.45 percent lead, 0.65 copper, and 3.62 zinc per ton. Comparable 1959 figures are 369,050 tons, 0.066 gold, 1.69 silver, 2.29 lead, 0.65 copper, and 3.60 zinc. Mine development kept ahead of production and resulted in an increase in ore reserves despite the greater tonnage mined during the year. A total of 10,461 feet of development and 7,724 feet of diamond drilling was done on three vein systems. The **Black Bear** was developed on the 2,000, 1,600, and 900-foot levels with new ore reserves added in the upper southeast section at No. 2

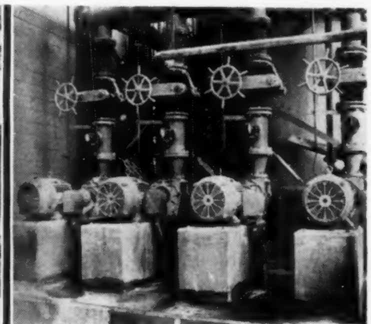
Virginia-Carolina Chemical Corp. Selects Massco-Grigsby Pinch Valves for New Phosphate Plant

200 Valves—sizes from 3" to 10"—
types from handwheel to automatic operation.

Based on its previous experience with a large number of Massco-Grigsby Pinch Valves in its plants at Homeland and Clear Springs, the Virginia-Carolina Chemical Corporation purchased approximately 200 M-G valves for its new phosphate plant at Nichols, Florida. These valves were sold and serviced by Mine and Smelter's Sales Agent, R. H. Clark Equipment Co., Inc., Mulberry, Florida.



Two 12" Massco-Grigsby Hydral-Air Pinch Valves on mill tailings line at the Clear Springs Plant of Virginia-Carolina Chemical Corp. Valve system includes solenoids for remote push button control of opening and closing the valves.

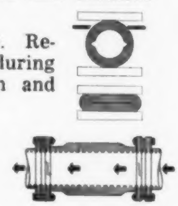


Four 6" and four 8" Massco-Grigsby Pinch Valves on the suction and discharge sides of the pumps at Virginia-Carolina Chemical Corporation's new Nichols plant.

Photo courtesy of Westinghouse Electric

Special Advantages of Massco-Grigsby Valves

- Rubber, Neoprene and special compounded rubber sleeves for corrosive and abrasive pulps and liquids.
- Patented "hinged" sleeve. Recesses serve as "hinges" during compression; reduce strain and permit tight closing.
- Unobstructed flow eliminates high friction loss, prevents contamination.



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The Massco-Grigsby Hydral-60 System consists of one or more pinch valves with a single automatically operated hydraulic pump which may be operated by electric motor or air from normal plant supply system . . . permits controlled circuitry for any operating requirement.

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block while northwesterly drifting on the 900 level disclosed additional future grade ore. Drifting was carried out on the 2,400 and 2,900-foot Argentine vein levels. Of particular interest was the 2,400-foot southeast drift where disseminated mineralization in the Telluride conglomerate host rock was found adjacent to the vein. The **Tomboy** 1,200-foot drift was advanced to develop down-dip extension of ore known in the Tomboy mine. The **Atlas, Crusher, Ajax, Tomboy,** and **Argentine** structures were diamond drilled during the year. John S. Wise is general manager.

Consolidated Parnett Corporation has started to reopen the old **Wellington** zinc-lead-silver-gold mine near Breckenridge, Summit County, Colorado according to general manager Charles O. Parker II. Consolidated Parnett is the operator and general partner in the **Wellington Mine Association** which holds leases on the Wellington and owns a large group of surrounding claims. After the old workings have been rehabilitated plans call for sinking of a winze 230 feet deep below the main adit level and development of a new level to seek the down dip extension of veins stoped above the adit. After ore bodies have been developed plans call for the building of a 150-ton-per-day differential flotation mill to treat not only Wellington, but custom ore from other Summit County mines.

Union Carbide Nuclear Company of Grand Junction, Colorado has sent two geologists to San Simon Valley 12 miles north of Bowie, Arizona to stake 200 claims on what is reported as zeolitized volcanic ash. The company's use of this material is still unknown.

Eastern

International Minerals and Chemical Corporation has two expansion projects underway at its **Noralyn** phosphate mine and mill at Bartow, Florida. Dams for an expanded tailing disposal area are now being built with a new **R. G. LeTourneau** "Pacemaker" L-60 twin scraper. Two Diesel-electric generators produce 700 horsepower to drive the eight electric wheels. It weighs 143,000 pounds and loads and hauls 55 tons per trip. Expansion of the washer is now underway to bring capacity in line with the new calcining plant and will materially increase washing and storage capacity. **Western Knapp Engineering Company** of San Francisco, California has the washer contract with completion scheduled by March 1, 1962.

The **United States Geological Survey** has just released a new map locating 500 mines, quarries, and open pits in Maryland. Each mine has a list of references. Mineral Investigation Map MR 12 can be purchased for $0.60 from the Survey in Washington, D. C.

Armour Agricultural Chemical Company has installed two dust collectors at its phosphate mill east of Bartow, Florida. Two 50-foot tall stainless steel water spray scrubbing towers trap dust in the effluent air from the rock drying kiln. Armour is now building a new phosphate plant at Fort Meade which is scheduled for operation in early 1962. Harold N. Hedrick, is Works Manager at Bartow.

Ore reserves at the present price of copper will only sustain mining and milling operations at **Nipissing Mines Company's Ore Knob** mine near Jefferson, North Carolina until early 1962. However, a series of studies are being made to determine the economic feasibility of making and marketing an iron concentrate from mill tailing. If this should prove possible the mill might operate an additional 12 to 18 months. During 1960 289,942 tons of ore was mined and milled from which 10,875,566 pounds of copper, 1,694 ounces of gold, and 23,300 ounces of silver were recovered.

The rare earth ore bastnaesite will be the subject of continued and expanded research at Pennsylvania State University at University Park under sponsorship of the **Molybdenum Corporation of America.** Investigation of new uses for the rare earths and preparation of new rare earth products will be a phase of the project. The ore is mined at Molybdenum Corporation's mine at Mountain Pass, California, and processed at the firm's plants in Washington and York, Pennsylvania. The **Mountain Pass** mine contains the world's largest bastnaesite deposits.

Idaho

A surface hoist building 65 feet long, 40 feet wide, and 35 feet high has been completed at the **Lucky Friday** mine near Mullan, Shoshone County, Idaho, to house a 1,250-horsepower hoist. The hoist

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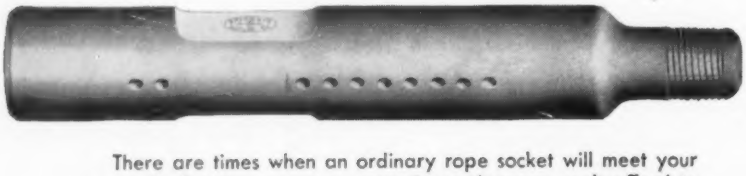

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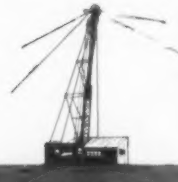

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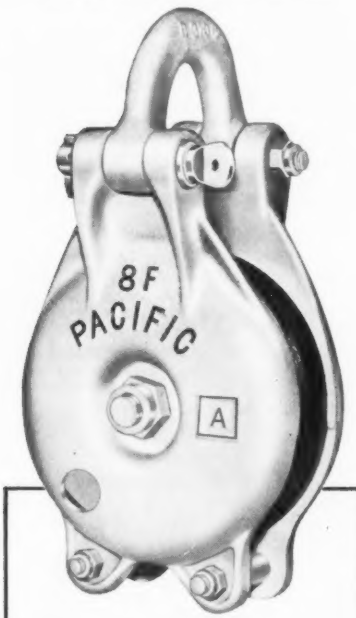

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will lift 150 tons hourly from a depth of 2,600 feet, from where most production now is coming, and 90 tons from a depth of 5,000 feet. The present underground hoist is limited to a depth of about 3,000 feet, the bottom of the mine at this time. A $1\frac{1}{2}$-inch cable will run uphill to a steel headframe which is to be built over the top of the main Lucky Friday shaft which has been raised 50 feet to the surface. The new hoist is scheduled to go into operation in late summer or early fall. L. J. Randall, Wallace, is president of **Lucky Friday Silver-Lead Mines Company.**

Clayton Silver Mines, Inc., is continuing to operate near Clayton, Custer County, Idaho, despite losses of about $6,000 monthly in the first three months of this year, because of heavy pumping and maintenance expenses involved in a shutdown. Ore reserves are ample but lead-zinc prices are too low for profitable operation. Norman M. Smith, Kellogg, is general manager.

Discovery of beryllium ore samples over an extensive area has been reported by Dave Bell, well-known miner of the Mackay area, Custer County. He has not pinpointed the site.

American Metal Climax Company has leased the **Ima** tungsten mine, Lemhi County, Idaho, and put a 10-man crew on sampling and other exploration work. The mine, formerly a major tungsten producer, was shut down in 1947 by **Bradley Mining Company** because of the low price of tungsten. The lessee has large molybdenum-tungsten operations at Climax, Colorado. Climax has also leased the **Howe Sound Company's** claims (**Master Mining Corporation**), Idaho, adjoining the **Ima** claims.

The **Pope-Shenon** copper mine southeast of Salmon, Lemhi County, Idaho, has been leased by Fred Brough and C. Walker Lyon, Salmon, to **McFarland & Hullinger**, Tooele, Utah, mining contractors, who have put an exploratory crew at work. Production was suspended three years ago because of a drop in the price of copper.

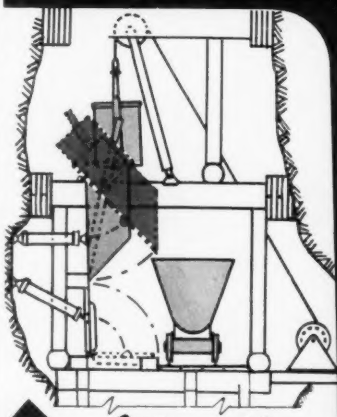
Nabob Silver-Lead Company has levied an assessment of $0.02 per share to raise approximately $60,000 to pay off indebtedness and keep the **Nabob** zinc-lead mine in Shoshone County's Pine Creek district in shape for a return to production with improved metal prices. H. J. Hull, Wallace, is president.

An expansion of iron mining on McCleary Butte near Tensed, Benewah County, Idaho, is planned this season by C. C. Hill of Spokane, Washington, who hauled more than 3,000 tons of ore from the butte last year. The ore was used by **Ideal Cement Company** at its Spokane Valley plant.

Iron Ranges

Iron ore shipments for April from Lake Superior iron mines were lower than in past years. Only 187,986 tons were shipped in contrast to 5,600,882 tons in April 1960. In April of this year no shipments left the major ports of Ashland, Duluth, Two Harbors, and Taconite Harbor. **United States Steel Corporation** shipped its first cargo from Two Harbors

Going in the HOLE? SAVE with . . .



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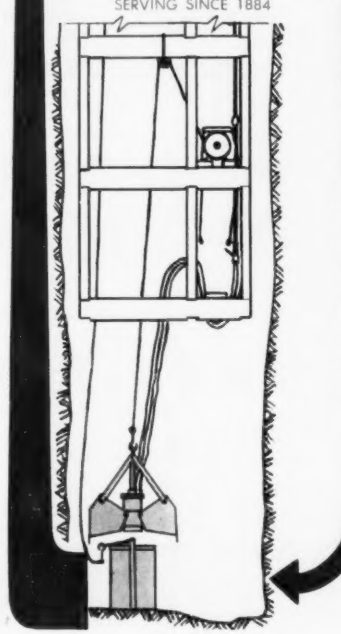

Same Truck With "T-1" Steel Body Hauls Extra Load

USS "T-1" steel body adds an extra five tons capacity to Mack trucks used for stripping overburden at one of the Mesabi Range iron mines of United States Steel Corporation's Oliver Iron Mining Division. The truck in the foreground with its 45 ton load is identical in every respect—except the body—to the one in the background. The "T-1" steel saved about 12 percent in truck weight enabling an extra five tons of payload without overloading. The new steel has proven to be highly abrasive-resistant under a wide change in temperatures during winter operation shown above or during hot summer weather. Oliver has also used the new steel for building 40 yard side-dump standard gauge railway cars for its Minnesota pits using rail haulage.

on May 1. Large Lower Lake stock piles of ore have delayed the shipping season.

North Range Mining Company has announced that it will terminate its lease and close its underground **Penokee** iron mine late this year. The present sales contracts will be filled from current operations, but all development work has been stopped. The mine owner, **Ironwood Mines Corporation,** will continue its deep underground diamond drilling program seeking additional ore bodies at depth.

Rhude Media Company is operating its plant on the Mesabi Range just west of Marble, Minnesota to produce ground ferrosilicon for the heavy media plants on the Range. This is the 12th season of operation. Rhude Media receives high grade ferrosilicon in 3.0 pound pigs from Keokuk, Iowa. This raw ferrosilicon is crushed and sized in two grades; 48 mesh, and 65 mesh. The products are trucked to heavy media plants on the Mesabi Range.

The **M. A. Hanna Company** has installed a long scraper trough a grizzley, and a 75 horsepower automatically controlled tugger on the 12th level of the company's **Homer-Wauseca** mine near Iron River, Michigan. The installation is expected to result in more efficient development and mining on the 12th level. In operation, the ore will be trammed to the trough and dumped. It will then be scraped onto the grizzley from where it will pass into a strip pocket at the shaft and be hoisted to the surface. The trough will allow continuous production in the event of haulage or other delays underground.

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Construction of **Jones & Laughlin Steel Corporation's** new **Cretaceous** semi-taconite plant at Calumet, Minnesota, is proceeding on schedule. All equipment, including a 22 foot diameter by 7 foot long Cascade mill, has been installed, and it is anticipated the plant will be in operation before July 1, 1961. At present, all ore will be treated by spirals, however, in the future a flotation section may be added to treat spiral tailings. **Western-Knapp Engineering Company** of San Francisco, California, is the prime contractor.

Montana

Northern Milling Cuts Gold Dust Vein 300 Feet Below Stopes

Northern Milling Company's extension of the low-level cross-cut Mason Tunnel has cut the Gold Dust vein 300 feet ahead of the face left in 1906 after driving 1,700 feet. The Gold Dust is one of only five lead-gold veins in the Marietta mine which have been mined in the past at higher elevations than the Mason Tunnel.

The vein is from 3.5 to 4.0 feet in width and drifting is being pushed to the north and south. The vein in the south drift is reported to assay as high as 15 percent lead, gold values in both drifts have been from 0.38 to 2.10 ounces of gold per ton.

Northern Milling operates the 200-ton-per-day Marietta flotation mill at the mine to treat Marietta ore, development ore from the nearby Miller mine, and ore trucked from the Strawberry mine near Pony. Recent operations have been on a one shift per day basis, but as the vein is developed on the Mason Level stoping will be started and the milling rate will be increased.

Northern Milling bought the Marietta claims in July 1958 and has been developing the mine since that date under the direction of Paul I. Raber, president. The mill was designed by consulting engineer William R. Wade, who described the unusual problem of separating barren arsenopyrite from gold bearing galena, chalcopyrite, and pyrite in the September 1960 issue of MINING WORLD, page 38.

At the **New Departure** silver mine near Dillon, Beaverhead County, Montana, **Spokane National Mines, Inc.,** has driven a 125-foot lateral around a caved area in the "zero level" tunnel which it is reopening to mine milling-grade ore left behind by high-graders at the turn of the century. An electric power line is being installed, preparatory to installation of an electric hoist, compressor, and pumps shipped from the company's **Sunset** mine near Kellogg, Idaho. Miners also are driving an adit on a vein uncovered in open-pit operations last fall. G. H. Allison, is company president.

Three areas in northwestern Montana offer potential mineral production, according to a cooperative survey of mineral resources undertaken in 1958 by the **Montana Bureau of Mines and Geology,** the **Great Northern Railroad,** and **Pacific Power & Light Company.** They are the Libby-Troy area, lead, zinc and gold with some silver and copper; the Hog Haven District, southwest of Kalispell, silver and lead; and the Eureka area, barite.

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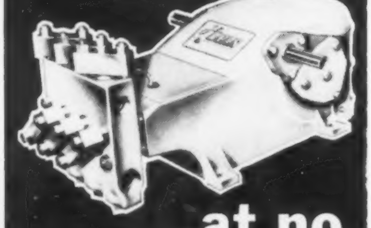

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Nevada

New safety records are being established daily by the **Nevada Mines Division of Kennecott Copper Corporation** at McGill. The 1960 safety record of the Division was the best in more than 50 years of operation. The flotation mill at McGill recently, for the first time, surpassed 1,000,000 man hours worked without a disabling injury. The old record was 637,223. John C. Kinnear, Jr., is Division manager.

While some additional lead-silver-zinc ore has been found by deep drilling at the Eureka, Nevada, mine of the **Ruby Hill Mining Company,** results have been termed so far "as disappointing" by the **Newmont Mining Corporation** which is the managing partner. Other partners are **Hecla Mining Company, Eureka Corporation, Ltd., Cyprus Mines Corporation** and **Richmond-Eureka Mining Corporation.** Unofficial reports indicate that very substantial reserves of zinc have been developed. The deep Eureka reserves under Ruby Hill have been the object of a long and costly development program by the **Eureka Corporation** for many years. One shaft was sunk to ore level, but a heavy inflow of water drowned the mine workings, subsequently some shallower ore was mined. The claims are controlled by **United States Smelting Refining and Mining Company** which owns 60 percent of the stock in the owning company—Richmond-Eureka.

New Mexico

The **Potash Company of America** has started delivery of potassium chloride to Taiwan under a contract awarded by the International Cooperation Administration. The crystalline potash will be used by the government of the Republic of China for making fertilizer. Shipments from Carlsbad under the $412,616 contract were made by railroad to Long Beach, California where the salt was loaded on ships. Potash Company of America has applied for extension of its potash-oil area in Eddy County to include nearly all of Section 13, T. 20 S., R. 29 E. and more than half of Section 14 in the same range and township to the presently defined area. The application was made to the New Mexico Oil Conservation Commission.

Anaconda Company's 3,000 ton per day RIP uranium mill at Bluewater, New Mexico, recently completed one full year of operation without a lost time accident according to manager Albert J. Fitch. About 400 men were working in the mill when the record was established. The record was made possible by the 13 departments comprising the mill's operating sections. Many of the departments have operated for several years without a lost time accident.

Duval Sulphur and Potash Company is now mining potash at its new mine 13 miles north of its mine and flotation mill in the Carlsbad Basin. Ore from the new mine is hauled by railroad to the mill and blended with ore from the main mine for milling. Production from the two mines will be balanced to operate the mill at capacity. Jerry Tong is Potash Division manager.

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Utah

During the first quarter of 1961 **Standard Metals Corporation** made a net profit of $276,000 from uranium ore sales from the **Big Buck** mine in San Juan County, Utah having a gross value of $541,000. Comparable 1960 figures are $334,000 and $602,000. Standard is now shipping low grade ore (0.20 to 0.26 percent U_3O_8) to **Texas Zinc Minerals Corporation's** Mexican Hat mill under a long term contract. After March 1962 0.32 to 0.40 percent ore will be shipped to take advantage of a higher sales price. Standard has more than enough reserves to assure contract deliveries through 1966. Profits from uranium operations have been used to finance the base metal development project at the **American Tunnel** in San Juan County, Colorado. W. R. McCormick of Moab is Standard president.

New Park Mining Company has cut the gold bearing **Pearl** fissure on the 2,005-foot level of its **Mayflower** mine at Park City, Utah. This is the lowest level of the mine and is being driven westward under an Office of Minerals Exploration program to seek replacement ore in the Madison limestone. All Mayflower production to date has come from replacement and fissure ore above the **Madison.** W. H. H. Crammer, company president, recently announced that New Park is planning a 200-ton-per-day differential flotation mill and that there is a good chance that the mill will be assembled in a rock chamber to be excavated in the mine. Tailing would be back filled in old stoped areas as well as current stopes. New Park has always had an expensive hoisting and tramming operation to bring ore to surface through the long Mayflower adit. All ore has been shipped to Salt Lake Valley custom flotation mills for treatment as New Park has never had its own mill, despite the fact that it has mined 1,397,912 tons of ore with a gross value of $36,641,693.

Washington

Silver Hill Mines, Inc., of Spokane has been organized to acquire a 25 percent royalty interest in a tungsten-tin mining and milling operation on Silver Hill, five miles southeast of Spokane's city limits. Incorporators are Halvor Halvorson, Spokane construction contractor, Herbert B. Jones, Carl A. Coon, Dr. Roy T. Pearson, and Elmer Lindahl, all of Spokane; Kae H. Sowers and L. H. Jorgens, Opportunity; James W. Fox, Greenacres; Harold W. Ebbetts, Sandpoint, Idaho, and R. E. Harris, Zolfo Springs, Florida.

Wyoming

Hidden Splendor Mining Company is evaluating mining methods to use at its wet underground **Peach** uranium ore body in the Gas Hills. Extensive reserves have been blocked out by surface drilling and careful plans must be made to achieve low cost mining. All the company's Wyoming production to date has come from the **Sunset** open pit mine. Dale I. Hayes is vice president and manager of mines.

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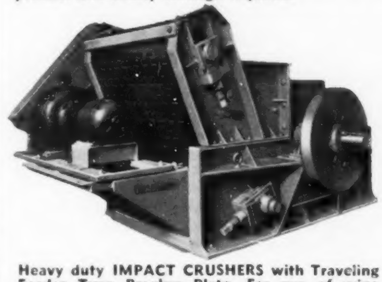

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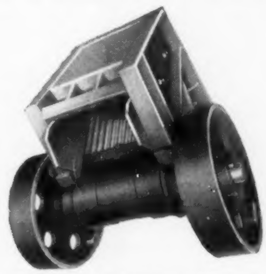

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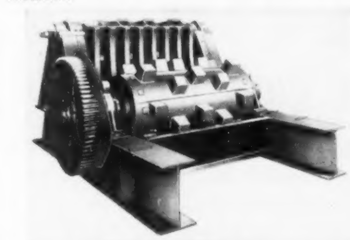

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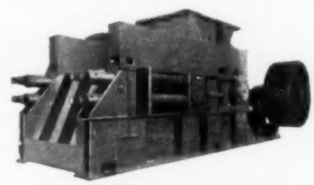

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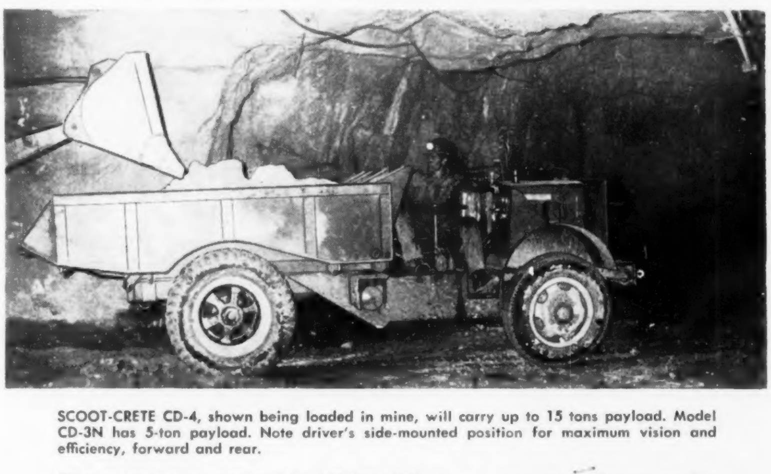

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sinking the two shafts at **Stauffer Chemical Company's Trona** mine on a three shift per day basis. The two shafts, one for men and ventilation and the other for hoisting, will be 1,000 feet deep. The man shaft was over 400 feet deep the first of May and is scheduled to be finished during June. The larger hoisting shaft was 100 feet deep at the same date. A 10-mile-long railroad has been built to the mine northwest of Green River. Installation of the machinery in the refinery is underway as the building is being erected around it.

Petrotomics, Inc., is shipping uranium ore from its new T.S.G. No. 1 open pit mine in Shirley Basin to the Jeffrey City mill of **Western Nuclear Corporation.** Petrotomics has a contract calling for the **Atomic Energy Commission** to buy 1,024,000 pounds of uranium concentrate (in ore) before March 31, 1962, but the AEC reserves the right to designate where the ore will be milled and picked Western Nuclear for first shipments. Petrotomics ore may also be directed by the AEC to other mills including **Cotter Corporation** at Canyon City, Colorado. Petrotomics is owned by **Kerr-McGee Oil Industries, Tidewater Oil Company, Skelly Oil Company**, and **Getty Oil Company.**

Vipont Mining Company is planning the development of an open pit gypsum mine 35 miles northwest of Shoshoni, Wyoming on the Wind River Indian Reservation according to Alfred Ellerby, company president.

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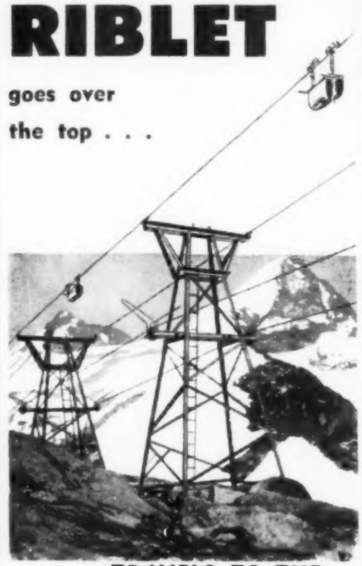

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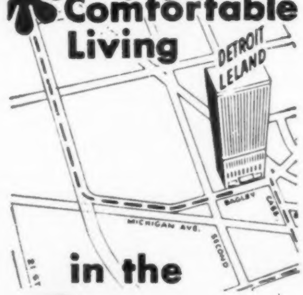

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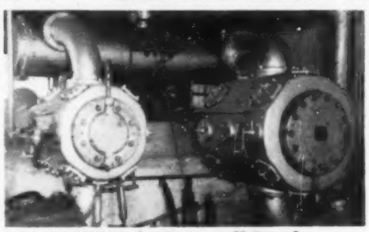

1000 cfm Ingersoll-Rand Compressor XCB

46—Galigher No. 48, 15 HP
32—Denver Sub A, No. 24, 10 HP

HYDRO SEPARATORS
1—36' x 10' Process Engineers, Steel tank
2—24' x 8' Process Engineers, Steel Tanks

JIGS
1—12" x 18" Denver Duplex, Mineral
1—16" x 24" Denver Duplex, Mineral
1—42" x 42" Yuba, M-8, 2 cell
12—42" x 42" Yuba, M-8, 4 cell

LOCOMOTIVES
1—2½ Ton G.E. Battery, 24" ga
1—8 Ton Goodman, Battery, 24" ga
7—1½ Ton Mancha "Little Trammer" 18"-24" ga
1—4 ton Mancha "Electric Mule" 24" ga
1—8 ton Plymouth Diesel, DHD, 24" ga
1—6 ton Mancha "Std AN," Battery, 24" ga

MAGNETS
1—24" x 24" Magnetic Pulley 250 V. DC
1—24" x 30" Dings Magnetic Perma-Pulley

MILLS
1—7' x 48" Hardinge Conical, Lg. Trunnion, 150 HP
1—7' x 22" Hardinge Conical, Lg. Trunnion, 75 HP
1—7' x 36" Hardinge Conical, Lg. Trunnion, 100 HP
1—7' x 5' Allis Chalmers, grate type, 150 HP
1—5' x 10' Marcy, overflow, 100 HP
4—11-3-6-10 Hardinge Tricone, 600 HP

MUCKING MACHINES
4—#21 Eimco Rocker Shovel, 24" ga
5—#12 B Eimco Rocker Shovel 24" ga
5—Eimco Model 105, Overhead
1—No. 21 48" ga Eimco with #3 Slope Attachment

PUMPS
1—2GT Ing. Rand 50 HP 440 V
2—1MRVN-7½ Ing. Rand 7½ HP, 440 V
1—1MRVH-15 Ing. Rand 15 HP 440 V
2—2MRV-25 Ing. Rand 25 HP 440 V
2—5RVL-30 Ing. Rand 30 HP 440 V
2—16" Cascade Sump, 7440 gpm, 30 HP
1—2" Denver Equip. Simplex Diaphram
1—6" Fairbanks Morse, 300 HP Regutron Control
2—14" Yuba, Model AA, 250 HP 5500 gpm
1—10" Yuba, Model S, 2400 gpm
1—16" Wintroath Deepwell, 100 HP Regutron Control
2—8" Dorrco Duplex, Type W, 5 HP
3—6" Dorrco Duplex, VM, 3 HP

VACUUM PUMPS
2—18" x 16" Ing. Rand ER-1 15 HP 440 V
1—17" x 10" Chicago Pneumatic NISB 25 HP

SCREENS
1—41" x 66" Jeffrey-Traylor, FB-2, 1 deck, MG
1—9' dia x 54½' Yuba, Trommel, 100 HP
3—4' x 12' Tyler Tyrock, 1 deck 10 HP
3—6' x 14' Hewitt Robins, MH-11, Scalping
2—6' x 12' Allis Chalmers, Lowhead
1—4' x 8' Tyler Hummer
1—4' x 10' Tyler Hummer

SHOVELS
1—20B Bucyrus Erie W/dragline
1—111M Marion Diesel Electric W/3½ yd Dragline
1—54B Bucyrus Erie Dragline
1—170B Bucyrus Erie, 7 yd. Electric

THICKENERS
1—100' Dorrco Traction, 3 HP gearmotor
1—120' Dorrco Traction, Type IC, 5 HP

TRUCK
1—15 ton Mack Off Highway, Model LRX

WEIGHTOMETER
1—18" Merrick, Model E, w/Rateograph

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Enclosed bucket elevator, 50' high, 10 hp

Allis Chalmers Low-Head Vibrating Screen, 3' x 6', 3 hp

Allis Chalmers Rolls (crusher) 24" x 14", 20 hp

Belt Feeder, 18" x 10', 1 hp

Wemco Remer Jig, 5' x 16', two 7½ hp

Wemco Classifier, 36" x 19'3", 3 hp

Wemco Model C Solids Pump, 3", 15 hp

Columbian Special Bolted Tank 15'4½" dia. x 16'1" shell with 45° hopper in 9'11½" shell

Hummers Vibrating Screen, double deck, 3' x 10'

TEJAS BARITE, INC.

P.O. Box 13216, Houston 19, Texas

Telephone JA 4-7561

Crusher 20 x 36 A-W-Lima roller-bearing
Crusher 15 x 30 Buchanan Blake Type
Crusher 12 x 30 Kue-Ken Model 69 jaw crusher
Crusher 10 x 20 Denver Eq. roller-bearing
Crushers Two 18" Kue-Ken Gyracones
Mill 4 x 10 Hardinge rod mill; periph. end dis
Mill 6 x 4½ Straub grate discharge
Mill 5 x 6 Colo. Iron Wks., over-flo dis
Mill 5 x 4 Eimco with new ball-charge
Filter 6 ft. 3-Leaf Eimco w/vac. eq
Flotation 6-Cells 56 x 56 Fag v-belt-dr
Magnet 40" dia. Stearns Electro w/rectifier
Thickener 28 x 10 Dorr low-head w/steel tank

PAUL F. SMITH
39 W. Adams St. Phoenix, Arizona

HOIST

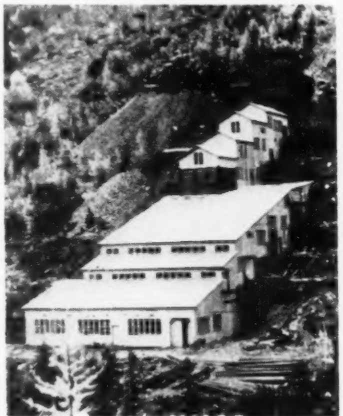
One Nordberg double drum 10' dia., 10' face, both drums clutched, 4500 ft. 1½" rope, 1200 FPM, 38,000 lbs. line pull, 1250 H.P., 2200 volt, 3 phase, 60 cycle, with all electrical and mechanical controls. Located Michigan.

A. J. O'NEILL
Lansdowne Theatre Building
Lansdowne, Pa.
Phila. Phones: MAdison 3-8300 - 3-8301

16' Gayco Air Separator W/Motor
2—5'x8' Kennedy Van Saun Air Swept Ball Tube Mills with disc feeders, fans, piping
4½'x9' KVS Air Swept Ball Mill
2 Wemco 2M—HMS Plants
5' x 5', 6' x 4' & 6' x 9' Traylor Ball Mills
No. 56 and 7'x15' Marcy Ball Mills
10' x 48" & 5' x 22" Hardinge Ball Mills
4'x11' & 7'x15' Marcy Rod Mills
20" Allis Chalmers Gyratory Crusher
12" x 26", 14" x 28", 18" x 36", 30" x 36", 48" x 60", 66" x 84" & 48" x 72" Jaw Crushers
8" x 10" Denver Jaw Crushers, rebuilt
24"x14" & 42"x16" Type B A.C. Roll Crushers
5½' Symons Std. Cone Crusher
7' Symons Snort Head Cone Crusher
78"x36'6" Akins Duplex Spiral Classifier
8'x37'x19' Dorr Bow Rake Classifier
6'x50' & 8'x60' Rotary Dryers
3'x30', 7'x120' & 9'x162' Allis Chalmers Rotary Kilns
4—30"x32" Dings Magnetic-Head Pulleys
Model BX-100 Sutton Steel & Steel Table
2—6'x12' A.C. Ripl-Flo 2-Deck Screens
8, 12, 23, 25, 45, 100 & 115 ton GE & Alcoa Diesel Electric Locomotives
25 ton Ind. Brn. Hoist Dsl. Loco. Crane
690', 1100', 1500', 2230', 3078' & 3600' Inger-Rand Elec. Compressors
2—15 HP Inger-Rand 2D Slushers
500—50 ton & 70 ton Gondola Cars
DARIEN, 60 E. 42nd Street, N.Y. 17, N.Y.

W. R. WADE

Consulting Mining Engineer



Another **WADE** Designed and Built

GOLDMILL

Operating data at this mill

Gold Recovery 97%
Silver Recovery 92%
¾ of Gold as Bullion
¼ of gold in $1000. per ton concentrates
MILLING COSTS $1.15 per ton

W. R. WADE
MARYSVILLE, MONTANA
Cable WADE HELENA
Telephone Helena Hickory 2-0105

FOR SALE

Drum filter, Oliver, 14' x 18', oscillating agitator
5—Thickeners, 12' x 20' Wemco, low-head, gear motors, steel tanks, near new cond
8—Diaphragm pumps, 2" Simplex, gear head motors
Sand pump, 3" Wilfley
3—Steel sand leaching tanks, 50' dia. x 10', Wemco sand distributors
4—Steel tanks, 30' dia. x 12', welded
Vibrating screen, single deck, 30" x 60", Jeffrey-Traylor
Precipitation unit, Merrill Crowe, 80 bag
Compressor, 10" x 12", Sullivan horizontal
Compressor, C-P, OCE 23" x 13" x 16", synchronous motor
Compressor, Sullivan Angle Compound, 21" x 12" x 14"
2—Battery locomotives, Jeffrey 4-ton, 18" ga
2—Battery locomotives, Whitcomb 2½-ton, 18" ga
34—Mine cars, 1-ton side-dump, roller bearing, 18" ga
7—Mine cars, swivel-dump, roller bearing
5—Mine pumps, 300 gpm, 600' head, 75 hp
Motor, slipring 250 hp, 440/60/3, 400 rpm
Motor, slipring 100 hp, 440/60/3, 720 rpm
Write P.O. Box 7, Nevada City, Calif., or phone 273-4238

AMERICA'S LARGEST STOCK
ROTARY DRYERS & KILNS!

1—Vulcan 10' x 11' x 175' kiln, 13/16", 2-tire
2—National 10' x 78 dryers, ¾" shell
2—Hardinge 8'-8" x 70' dryers, ⅝" welded
1—Traylor 8' x 80' dryer, ⅝" welded
2—Davenport 8' x 60' dryers, 7/16" welded
2—8' x 56' rotary kilns, ½" welded
3—Stearns-Roger 8' x 40' dryers, ½"
1—7'-6" x 63' rotary kiln, ½" welded
1—7' x 6' x 100' rotary kiln, ½" shell
2—Bonnet 7' x 60' dryers, ⅝" shell
1—Bonnet 6' x 52' dryer, 5/16" shell
2—4'-9" x 32' rotary dryers, ⅜" shell

MILLS — PULVERIZERS — CRUSHERS

1—Hardinge 6' x 36" conical ball, 75 HP w/fan, classifiers, etc.
1—Hardinge 8' x 48" conical pebble mill
2—Hardinge 7' x 36" conical pebble mills
1—Raymond 66", 6-roller mill
1—Farrel 36" x 15" jaw crusher
1—Buchanan 24" x 13" jaw crusher, 50 HP.
1—Allis-Chalmers 5' x 5' ball mill, 75 HP.
3—Allis-Chalmers 5' x 22' ball-tube mills
1—Allis-Chalmers 6' x 16' ball-tube mill

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GOVERNMENT SALE

CHEMICAL PLANT
Fredericktown, Missouri
SEALED BID

OPENING DATE July 11, 1961, 2:00 P.M. C. S. T.

The Government's interest in 15.06 acres of land with mill type buildings and chemical plant equipment used in the production of mineral products such as cobalt, mineral and copper. Excellent steam plant, water softener plant, unlimited water, chemical test lab and machine shop, cooling towers and processing plant. Natural gas connected and standby propane available. Autoclaves, centrifuges, drum filters, high pressure compressed air system and steam lines in excellent shape. Project operating full capacity 7 days, 24 hour basis to April 1, 1961. Included in the sale are spare parts having an acquisition cost of approximately $175,000.00. An immediate inspection is recommended.

For invitation and Bid Form GSA G-Mo-464 write

General Services Administration
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7 miles from Needles

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ATLAS COPPER, INC. Mining Consultants, Examinations, Exploration, Research, Valuations, contract Negotiations, Management Mining Methods. Properties wanted. Ac 2-2821, P.O. Box 7132, San Diego 7, Calif.

GEOLOGIST MS, Chemistry BA, from leading universities, single, age 31 with commercial pilot license and own Cessna 180 desires full or part-time position with mining or mineral exploration company or consultant firm. Also has experience in glaciology and snow research. Write Box 108, Mining World, 500 Howard St., San Francisco 5, Calif.

ACTIVE GOLD PLACER OPERATION, for sale. Properties, machinery, water, etc. Immediate production obtainable. L. M. DRAKE, Fairplay, Colorado.

GOLD MINING PROPERTY

With a resort future

170 Acres, patented, Feather River country. Proposed dam will cover approximately 40 acres of ranch, giving about 1¾ miles lake frontage in a setting of pines. Over mile of year round stream with ponds. Secluded, yet only mile to Forbestown, gateway to South Fork Dams now under construction. 2500 elevation, clean air. Improvements include country home, new guest cabin, new shop building, large barn, sawmill.

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Tractors and Equipment - $40,000
Total price - $100,000 cash

Will sell with or without equipment. Estimated placer gold in meadow $125,000. Many business possibilities

Full details on request

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WANTED — Powellite deposit capable being mined with power shovels. Prefer large deposit of powellite containing at least 0.50% WO_3 and at least 0.50% Mo. Bank references furnished. Address P.O. Box 1022, Reno, Nevada.

SMALL MINE OWNER

NEW TYPE crusher—wet or dry. Eliminates ball mill in most ores. W. H. Wahl, 215 Cheyenne St., Golden, Colorado

CHRYSOCOLLA WANTED. We are interested in any quantity good grade with no tendency to disintegrate. Please send sample immediately! We will refund any expenses. The National Gem Stones Society Ltd., Tel-Aviv-121 Dizengoff St., Israel.

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One to five years experience; preferably in milling or research. Work in head office of mining supplier, New York area. Duties to include liaison with field sales force, research, production and customers.

State salary required

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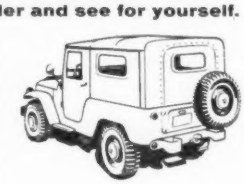
Land Cruiser has the power to climb steep 54% grades and plow through marsh or sand because it's powered by a mighty 135 HP 6-cylinder engine.

Land Cruiser has the room to take 7 passengers or a big payload of equipment because its hardtop or soft top bodies are 12½ ft. long, 5½ ft. wide.

Land Cruiser has the economy to slash your transportation costs. Initially, a Land Cruiser costs no more than any comparably equipped competitive 4-wheel drive vehicle of half the horsepower! From there on, you save on every trip because the Toyota Land Cruiser gets up to 28 MPG of gas from its highly efficient Toyota engine. You spend less time and money on maintenance because the Land Cruiser is more rugged, more durable, more **vehicle** than any of the others. And when it comes to regular servicing, you save again because every part of the Land Cruiser which needs periodic inspection is more accessible.

Drive a Toyota LAND CRUISER

at your nearest Toyota dealer and see for yourself.



For name of nearest dealer and further information, mail this coupon to TOYOTA MOTOR DISTRIBUTORS, INC. (Dept. M.1) 8701 Beverly Blvd., Los Angeles 48, Calif.

Send me more facts on the Land Cruiser and name of my nearest dealer.

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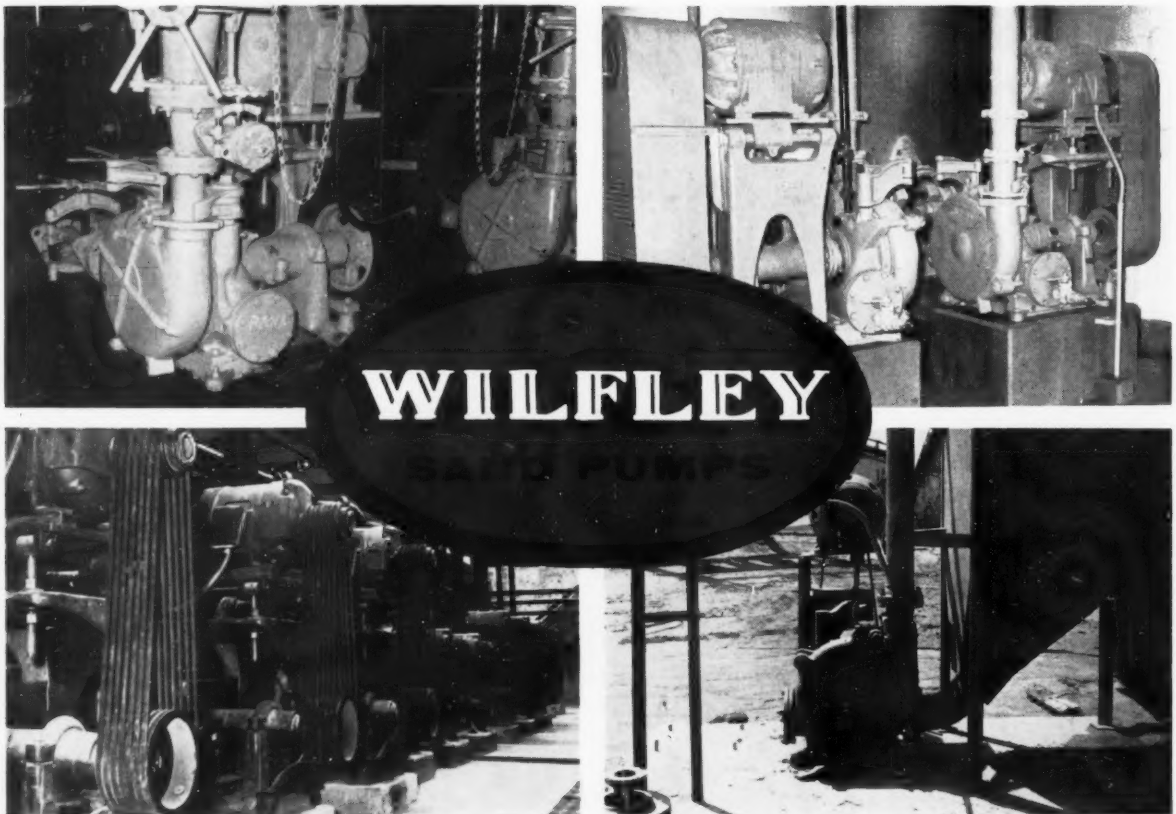

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